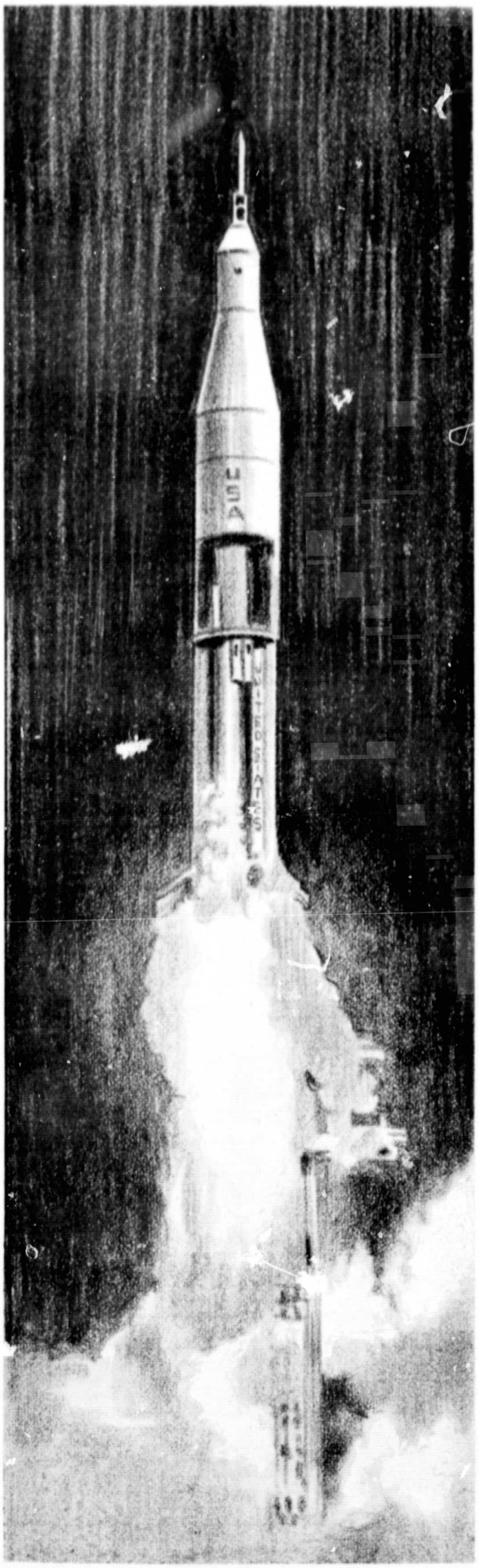

BB-3.4.4-3-201

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vehicle systems integration

OPTICAL INSTRUMENTATION DATA EVALUATION OF THE SA-204/LM-I SATURN IB LAUNCH VEHICLE

MARCH 8, 1968

SPACE DIVISION CHRYSLER CORPORATION

Technical Report HSM-R302-68 BB-3.4.4-3-201

OPTICAL INSTRUMENTATION DATA EVALUATION OF THE SA-204/LM-1 SATURN IB LAUNCH VEHICLE

by

L. F. Dennis
and
W. L. Cardwell

CONTRACT NAS8-4016
SCHEDULE II, VEHICLE
SYSTEMS INTEGRATION

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Systems Simulation and Integration Branch

CHRYSLER CORPORATION SPACE DIVISION

ABSTRACT

This report presents data describing certain phenomena observed from the photo/optical instrumentation of the SA-204/LM-1. This data includes a review of optical coverage and a time history of the sequence of events from vehicle first motion through ignition of the S-IVB J-2 engine. Data describing the operation of the umbilical swing arms, the vehicle vertical motion, growth and decay of the retro-rocket exhaust pattern, and the S-IB lateral motion during lift-off are also included. The vehicle performance from ignition to loss of view (LOV) was as predicted. The overall camera coverage was excellent. Approximately 93 percent of the cameras produced technically usable film.

PREFACE

This document was prepared by the Structures and Mechanics Engineering Department, Chrysler Corporation Space Division, Huntsville Operations, under authority of Contract NAS8-4016, MSFC-1, Amendment 38.

Acknowledgement is given to the Data Reduction Branch of the Computation Laboratory, Marshall Space Flight Center, for their aid and assistance. Additional information and/or comments should be directed to Mr. L. F. Dennis or Mr. W. L. Cardwell, Chrysler Corporation Space Division, Huntsville, Alabama (telephone 842-2519).

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SECTION I. INTRODUCTION

The uprated Saturn IB vehicle SA-204/LM-1 was launched from Vertical Launch Complex 37B on January 22, 1968 at 5:48 P. M. EST. The engineering photo coverage of this launch was excellent.

The engineering photo coverage provided by ninety-six cameras is generally divided into three major categories: eighty-three fixed cameras provide coverage during pre-launch operations and lift-off through the first three vehicle lengths of flight; twelve ground based tracking cameras provided coverage of the vehicle from first acquisition to loss of view or film depletion; and one airborne tracking camera provided coverage of the vehicle through S-IB/S-IVB separation or loss of view.

A timed history of events was established from the photo/optical data. The accuracy of the times quoted in this report were affected by three factors: the camera frame rate; the coded range timing recorded on the edge of the film; and the time to frame reference, marked at the beginning of each roll of film.

All times listed in this report are referenced to range zero which is the nearest whole second preceding vehicle lift-off. Range zero for SA-204/LM-1 was 2248 hours plus 08.000 seconds, Greenwich Mean Time (GMT) or 1748 hours plus 08.000 seconds Eastern Standard Time (EST). A general statement of times obtained from the engineering photographic data is as follows:

Event	Range Time (sec)
First Motion	0.17
Tower Clearance	7.27
Inboard Engine Cutoff Signal	139.10
Outboard Engine Cutoff Signal	142.16
Ullage Rocket Ignition	143.33
RetroRocket Ignition	143.62
J-2 Engine Fuel Lead Start	146.42
J-2 Engine Engine Ignition	146.91

SECTION II. PRE-LAUNCH EVENTS

A. S-IB LOX VENTS

Three cameras were programmed to cover the vent valves and venting of the S-IB LOX Tanks. Vent start and stop times were observed. All cameras operated as programmed with excellent coverage of the venting action. No malfunctions were observed.

B. S-IVB LOX VENT

One camera was programmed to cover the action of the S-IVB LOX vent valve and venting action. The camera focus was poor, however, venting action was noted. This camera does not cover the vehicle through lift-off as was required. The camera ran continuously during the hold periods and the film supply was exhausted approximately four hours prior to launch. No malfunctions were observed.

C. LOX VAPOR OBSERVATION

Three cameras were programmed to cover any vapor obstruction between the SVM2 theodolite and the ST124 guidance window. These cameras operated as programmed and no obstructions were observed.

SECTION III. PERFORMANCE OF THE PHOTO SYSTEM

Ninety-six engineering cameras were programmed to cover this launch. A number/percentage breakdown of camera performance follows:

Number of Cameras	Percent	Comments
2	2.1	Cameras did not operate
4	4.2	Cameras were out of focus and data were not usable
1	1.0	Camera produced no timing on film
89	92.7	Cameras produced technically usable film*

* This does not mean that data were obtained from all of these cameras; however, the camera set up and operation was as programmed. Twenty-six of these cameras were surveillance, malfunction and/or special test cameras and the film from these cameras was not processed.

SECTION IV. DATA REDUCTION ANALYSIS BY SYSTEM

A. VEHICLE FIRST MOTION

Two cameras were programmed to record vehicle first continuous motion. Both of the cameras produced usable film; however, the field of view was about 80 percent obscured by frost, ice, and smoke during the time first motion occurred. First motion was referenced to the first continuous motion of the targets (A) painted on the vehicle with reference to the fixed point (B) mounted on holddown arms II-III and IV-I (Figure 1). First motion was obtained from two other holddown arms as a further check of the data. The fin on the vehicle was used as the reference and a bolt head on the holddown arm as the fixed reference (Figure 2). These times matched within six milliseconds (Figures 3 and 4).

Event	Time (GMT)	Range Time (sec)
Vehicle First Motion	2248 hours + 08.170 (± 0.01) seconds	0.170

B. VEHICLE VERTICAL MOTION

One camera (35mm Mitchell) was programmed to record vehicle vertical motion for the first three to five meters of flight. The power plug to this camera fell from its socket and the camera produced about seventy feet of usable film; the camera was oriented too high; and some of the targets were obscured by frost and ice. These three factors limited the coverage to 0.6 meters of flight from which the trend of vertical motion and vertical velocity was established. A reference scheme of markers on the vehicle (A) and a fixed target on umbilical tower (B) were used to acquire the necessary data for the 0.6 meters of vertical motion and velocity (Figures 5, 6, and 7).

C. VEHICLE LATERAL MOTION AND TOWER CLEARANCE

One camera was programmed to observe any gross lateral motion of the vehicle and to record tower clearance time. This camera operated as programmed and usable data were obtained. No unusual lateral motion of the vehicle was observed (Figures 8 and 9).

D. GROUND SUPPORT EQUIPMENT

1. Holddown Arms

Eight cameras were programmed to cover the release of the eight holddown arms. The releases of all eight arms were timed and plotted (Figures 10 through 17). On two arms (II and IV-I), part of the holddown shoe was observed to remain with the vehicle after release (Figure 18). Also, it was noted that two of the vehicle support struts moved laterally just prior to the release of the holddown arms on which the struts were sitting (Figures 19 and 20). These observations were reported to the associated ground support equipment office at Kennedy Space Center.

The release times of the arms are as follows:

HDA	Time (GMT)	Range Time (sec)
II-III	2248 hours + 8.163 (± 0.010) seconds	0.163
I	2248 hours + 8.172 (± 0.010) seconds	0.172
IV	2248 hours + 8.174 (± 0.010) seconds	0.174
II	2248 hours + 8.183 (± 0.010) seconds	0.185
III	2248 hours + 8.189 (± 0.010) seconds	0.189
I-II	2248 hours + 8.189 (± 0.010) seconds	0.189
IV-I	2248 hours + 8.190 (± 0.010) seconds	0.190
III-IV	2248 hours + 8.190 (± 0.010) seconds	0.190

2. Short Cable Masts

Two cameras were programmed to cover the release and retraction of these masts. Both cameras produced technically usable film; however, the field of view was obscured by frost and ice during the time of release and retraction and the retraction of the masts was obtained from another source. The flame deflector cover of mast II fails

to close until forced closed by the flame of the vehicle (Figure 21). The release times of the two masts are presented below:

Mast	Time (GMT)	Range Time (sec)
Short Cable Mast I	2248 hours + 8.351 (± 0.010) seconds	0.35
Short Cable Mast II	2248 hours + 8.380 (± 0.010) seconds	0.38

3. LOX and Fuel Fill and Drain Masts

Two cameras were programmed to cover the release and retraction of the LOX and the fuel fill and drain masts. The release time of the LOX mast was not obtained because there was no timing on the film. The release time of the fuel mast was not obtained due to ice and frost in the field of view at the time of disconnect.

4. Swing Arms

Sixteen cameras were programmed to cover the release and retraction of the four swing arms. Eight were used to observe disconnect (Figure 22); four were used to obtain swing arm/vehicle clearance and four to obtain swing arm retraction rates (Figures 23 and 24). The cameras produced technically usable data with the following exceptions; one camera was out of focus and the time of the release could not be determined; one camera had a timing dropout after nine seconds; however, a time extrapolation produced the retraction rate; the cover panel at swing arm three connect point struck the swing arm head after release (Figure 25); the cover panel at swing arm one was observed not to close completely (Figure 26); the retraction rate of swing arm one was not obtained due to ice and frost in the field of view and on the quartz window. The release of each arm was referenced to the first frame of data showing continuous motion of the umbilical head. Figures 27 through 32 depict the angular displacement and velocity of swing arms two, three, and four.

5. Flame Impingement and Blast Damage to Launch Table

One camera was programmed to observe the damage to the launch pedestal caused by the flame and blast impingement. The

camera operated as programmed. Some items of interest noted on the film were the newly installed S-IB base region pressure transducers, the delayed closing of the flame deflector on the short cable mast, and the tearing loose of one hose on the pedestal (Figure 33).

E. VEHICLE STRUCTURAL SURVEILLANCE

1. Entire Vehicle

Two cameras were programmed to observe the entire vehicle during launch. These cameras operated as programmed and no malfunctions were observed.

2. S-IB Stage

Two cameras were programmed to observe the S-IB stage during thrust build up and lift-off. These cameras operated as programmed and no malfunctions were observed.*

3. Top of Launch Pedestal

Two cameras were programmed to observe the bottom one quarter of the S-IB and the launch table during thrust build up and lift-off. These cameras operated as programmed and no malfunctions were observed.*

4. S-IVB Stage

Three cameras were programmed to observe the S-IB/S-IVB innerstage and the S-IVB stage. The film from one camera was unusable due to poor focus. The other two cameras operated as programmed. No malfunctions were observed and no timeable events were recorded. However, an excellent view of the excess frost and ice caused by launch conditions (time, temperature, and dew point) is shown in Figure 34.

5. Apollo Interface

Four cameras were programmed to observe the Apollo system interface area during ignition and lift-off. One camera mal-

* These four cameras (2 and 3) provide 360° coverage of the launch pedestal.

functioned and three cameras operated as programmed. No other malfunctions were observed.

6. Entire Vehicle to Three Vehicle Lengths

Four cameras were programmed to provide 360° coverage of the vehicle during first three vehicle lengths of flight. One camera malfunctioned and three cameras operated as programmed. The field of view of one of the three was obscured by smoke during the entire film run. No other malfunctions were observed.

F. TRACKING CAMERAS

1. Entire Vehicle (Short Range)

Three cameras were programmed to follow the entire vehicle from lift-off through loss of view. These cameras operated as programmed and no malfunctions were observed. One camera records three particles in the same field of view as the vehicle during early flight (just prior to max Q). This type of particle has been observed before and is presumed to be ice.

2. S-IB Stage (Medium Range)

Three cameras were programmed to follow the S-IB stage until the entire vehicle comes into view and then track until loss of view. Some staging events were timed and no malfunctions were observed (Figure 35).

3. Apollo Interface (Medium Range)

Two cameras were programmed to cover the Apollo interface area from lift-off through loss of view. No malfunctions were observed.

4. Entire Vehicle (Long Range)

Four tracking cameras (IGOR and ROTI) located north and south of the flight line were programmed to cover the vehicle from first acquisition (about 25 sec) through film depletion. These cameras operated as programmed and no malfunctions were observed. The

separation sequence was timed from each camera and the times correlated (Figures 36 and 37). One of these cameras was linked with the real time television network.

5. Entire Vehicle (Long Range; Airborne)

One tracking camera was mounted on the ARIA I aircraft. This camera was programmed to track the vehicle from launch plus twenty seconds through film depletion. The camera operated as programmed and the separation sequence was timed. No malfunctions were observed. The engine cutoff sequence, both inboard engine cutoff (IECO) and outboard engine cutoff (OECO) and S-IB/S-IVB separation events were timed and are presented below:

Event	Time (GMT)	Range Time (sec)
IECO Signal	2250 hours + 27.101 (± 0.03) seconds	139.10
Flare - Start	2250 hours + 28.200 (± 0.03) seconds	140.20
Flare - End	2250 hours + 28.687 (± 0.03) seconds	140.69
OECO Signal	2250 hours + 30.160 (± 0.03) seconds	142.16
Ullage Rocket Ignition	2250 hours + 31.234 (± 0.03) seconds	143.33
RetroRocket Start	2250 hours + 31.622 (± 0.03) seconds	143.62
RetroRocket End	2250 hours + 33.305 (± 0.03) seconds	145.31
J-2 Engine Fuel Lead Start	2250 hours + 34.420 (± 0.03) seconds	146.42
J-2 Engine Ignition	2250 hours + 34.913 (± 0.03) seconds	146.91

SECTION V. PRE-LAUNCH MALFUNCTION/SURVEILLANCE AND SPECIAL TEST CAMERAS

A. MALFUNCTION/SURVEILLANCE

The films obtained from the twenty-two pre-launch malfunction/surveillance cameras is generally not processed unless a special problem area occurs. No anomalies have been found to date and the film will be retained at KSC. All of these cameras indicated a full run of the film loaded.

B. SPECIAL TEST

In an effort to provide better data for future flights, four cameras were loaded with a new type of Extended Range (ER) film to determine whether or not it is better suited for specific jobs than film presently being used. The results of these tests will be made available after analysis by Kennedy Space Center Photographic Operations.

SECTION VI. CONCLUSIONS

The engineering sequential camera coverage for the flight of SA-204/LM-1 was the best coverage that has been observed on the Saturn IB program. The 92.7 percent technically usable film is the most reliable system performance that has been produced during the Saturn program.

Overall film delivery was good. All film to be delivered on L+1 and L+4 days was received. All except six rolls of film to be delivered on L+7 days was received; the six rolls of film were received from four to twelve days late.

No major anomalies were observed during the launch, however, data were lost from five cameras due to the excessive frost and ice that had accumulated on the vehicle prior to launch. This is attributed to the low winds, dew point, and low radiation level at the time of launch.

APPENDIX A. ILLUSTRATIONS

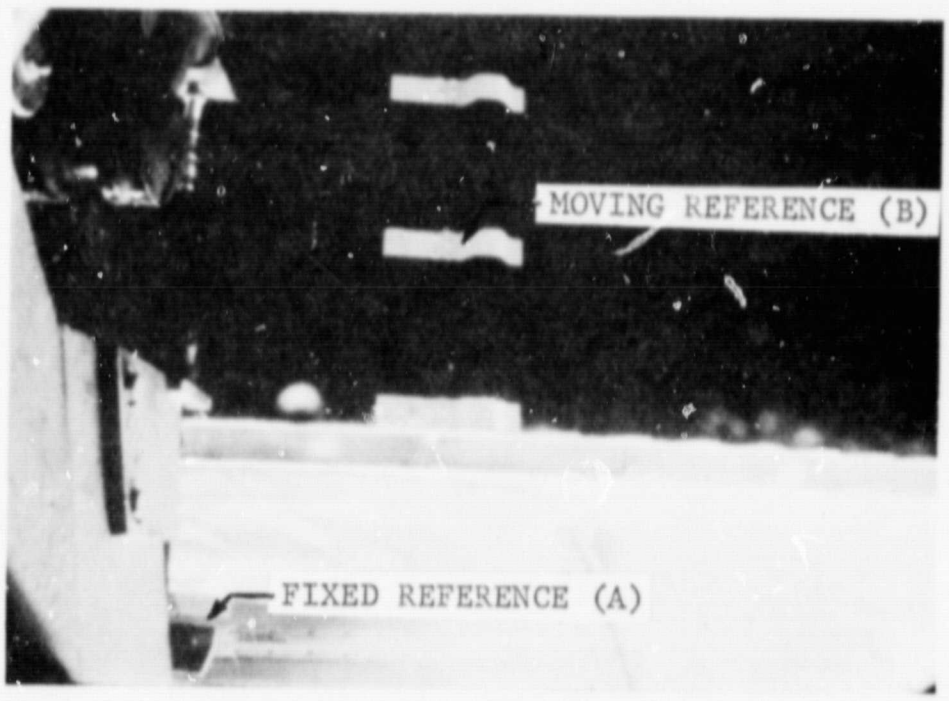


FIGURE 1. VEHICLE FIRST MOTION REFERENCE TARGETS

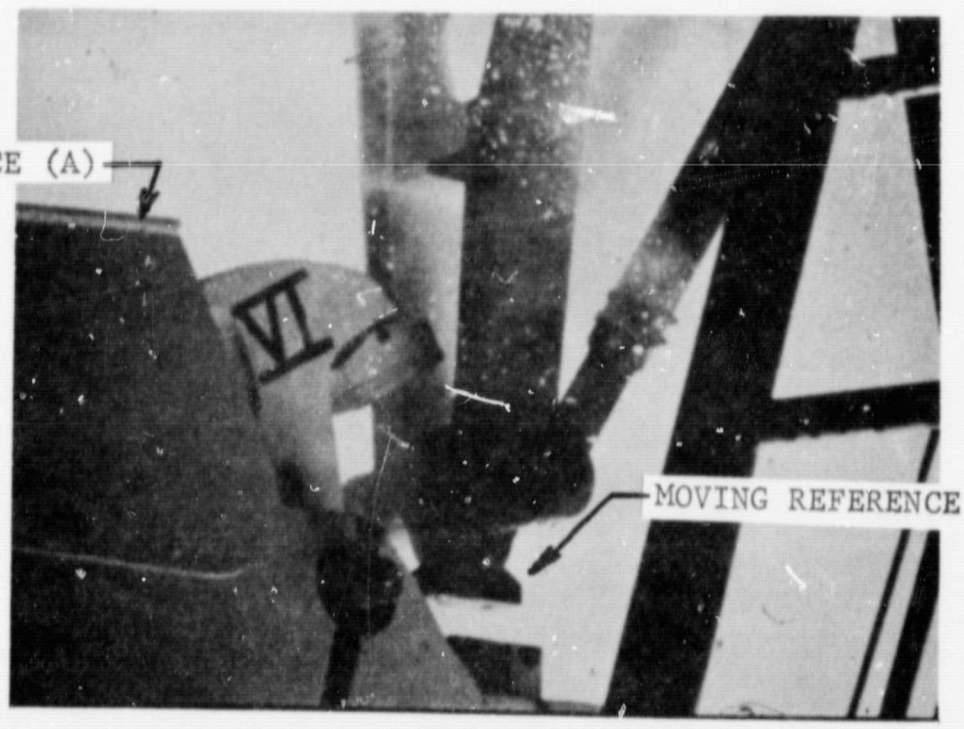


FIGURE 2. VEHICLE FIRST MOTION REFERENCE TARGETS ON HOLDDOWN ARMS

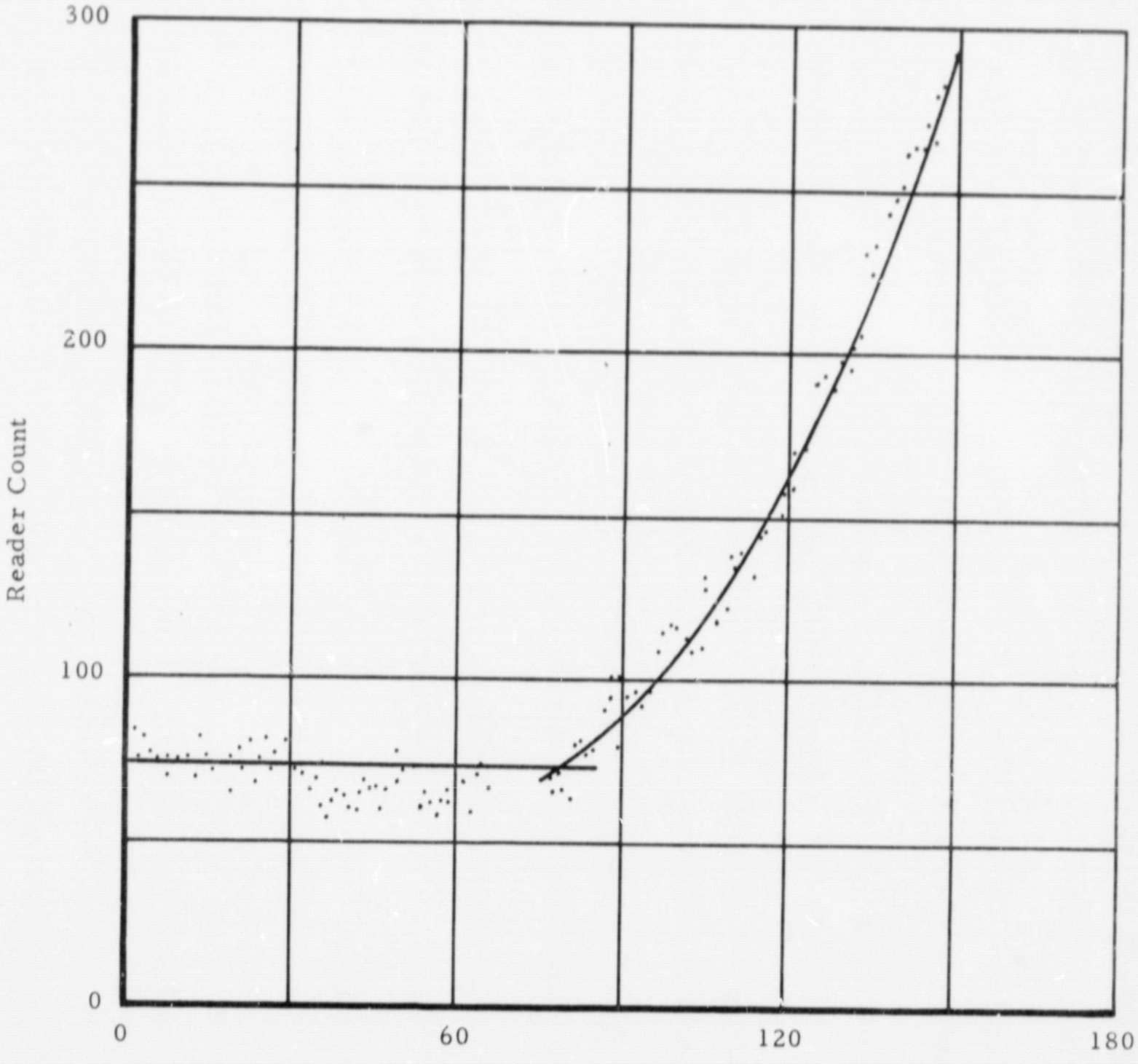


FIGURE 3. VEHICLE FIRST MOTION HOLDDOWN ARM IV

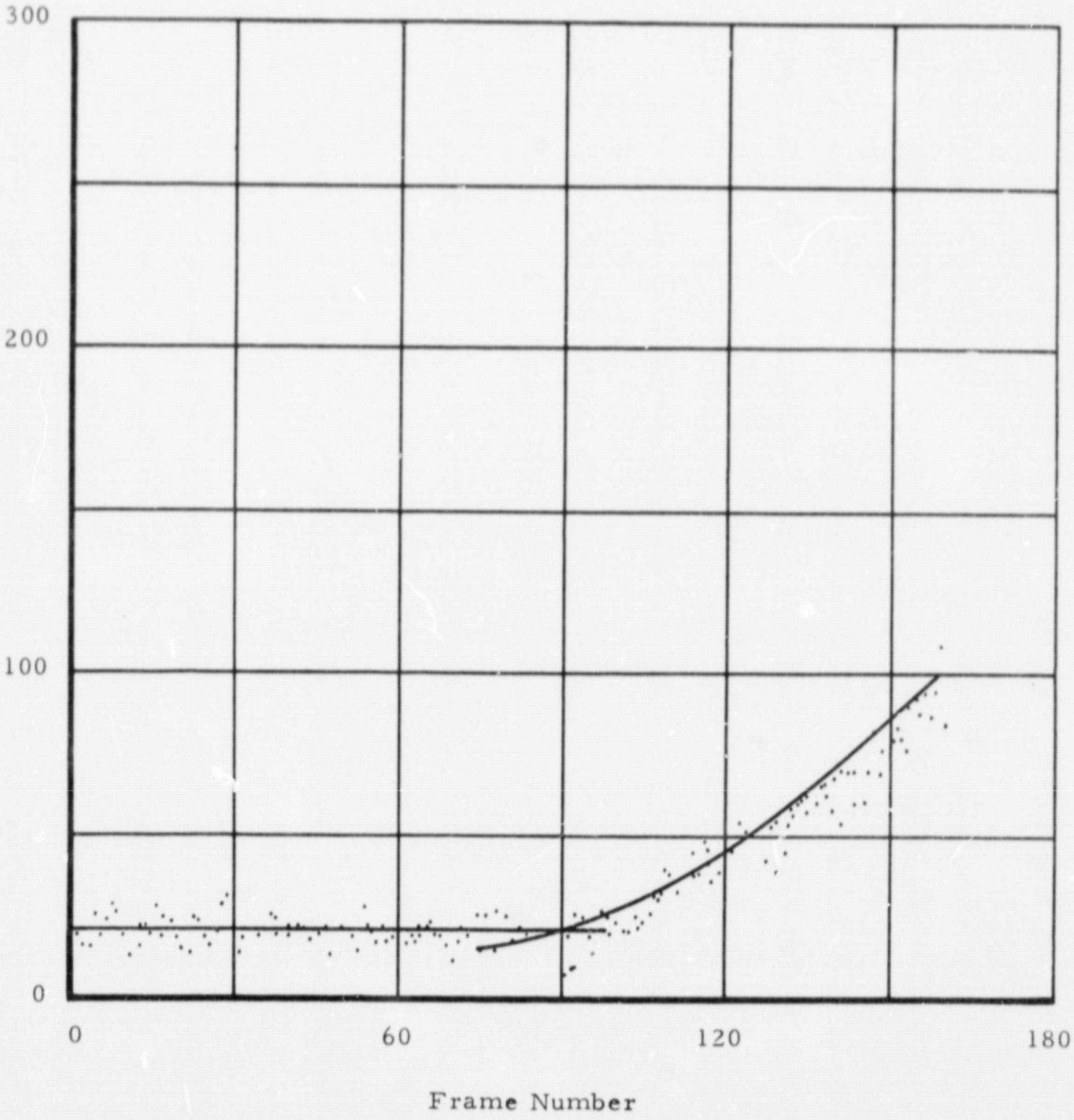


FIGURE 4. VEHICLE FIRST MOTION HOLDDOWN ARM II-III

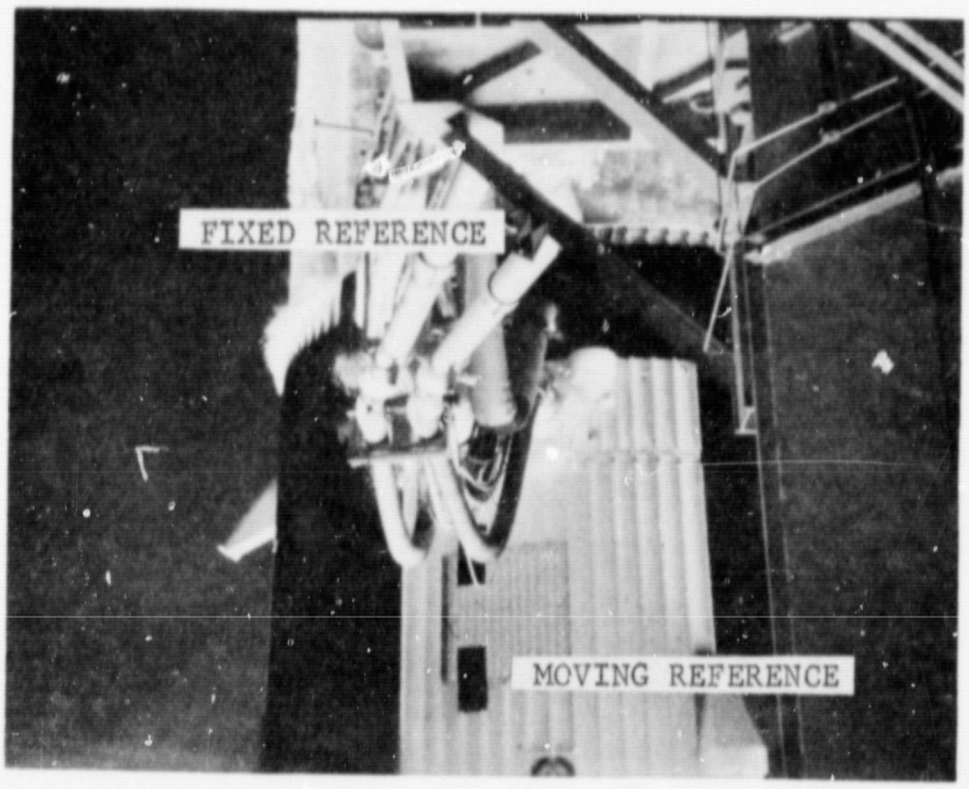


FIGURE 5. VEHICLE VERTICAL MOTION REFERENCE TARGETS

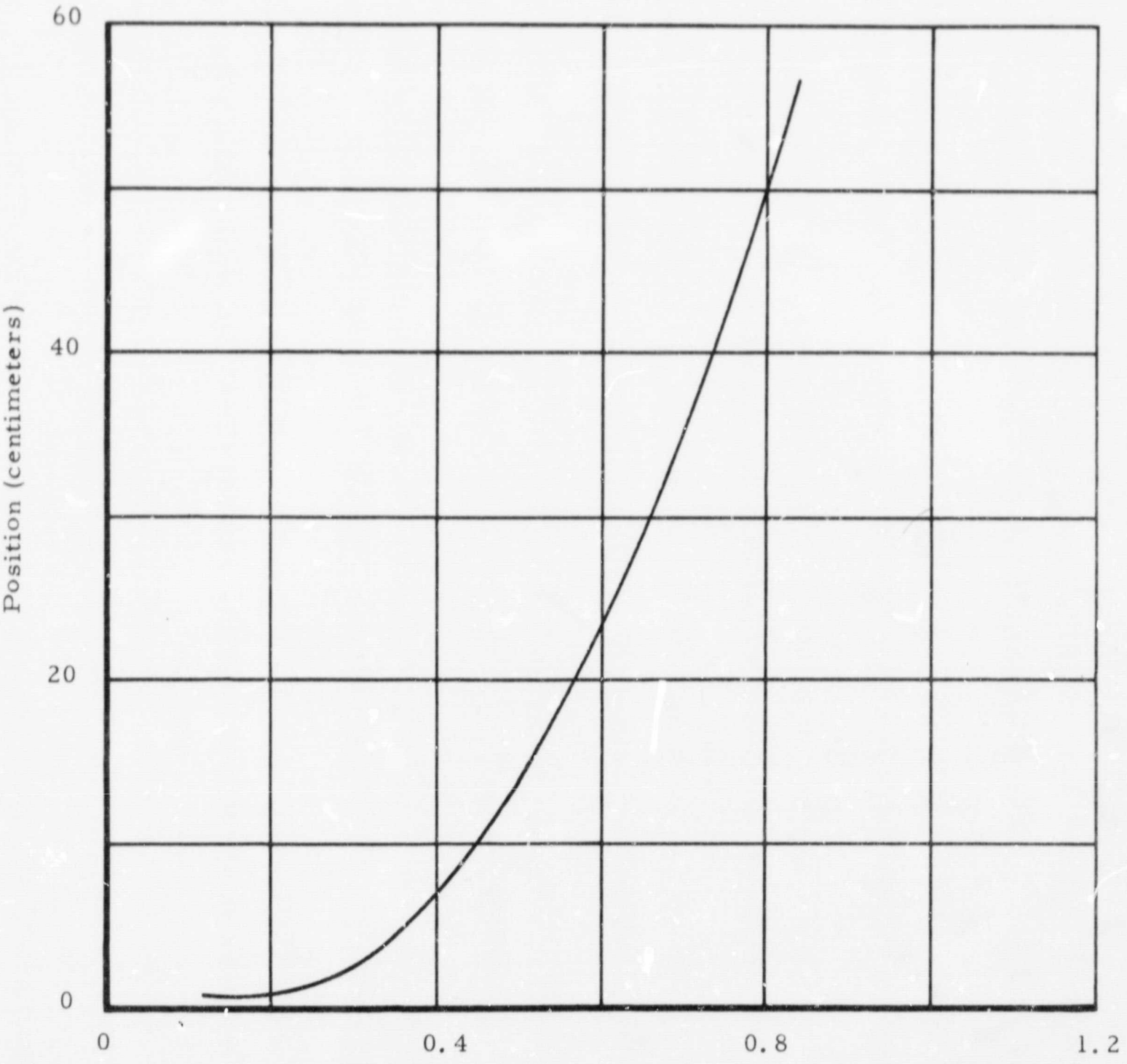


FIGURE 6. VEHICLE VERTICAL POSITION

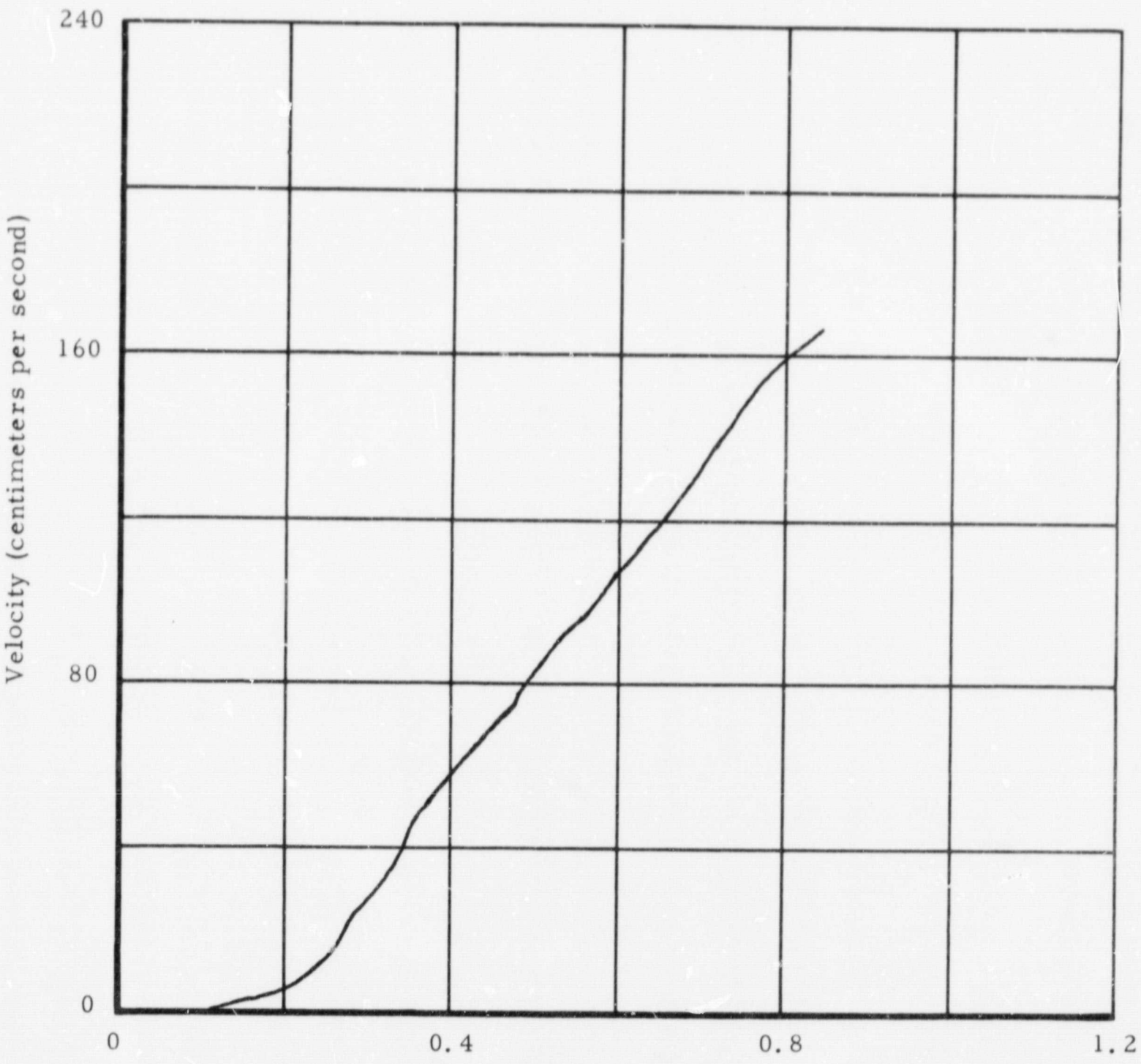


FIGURE 7. VEHICLE VERTICAL VELOCITY

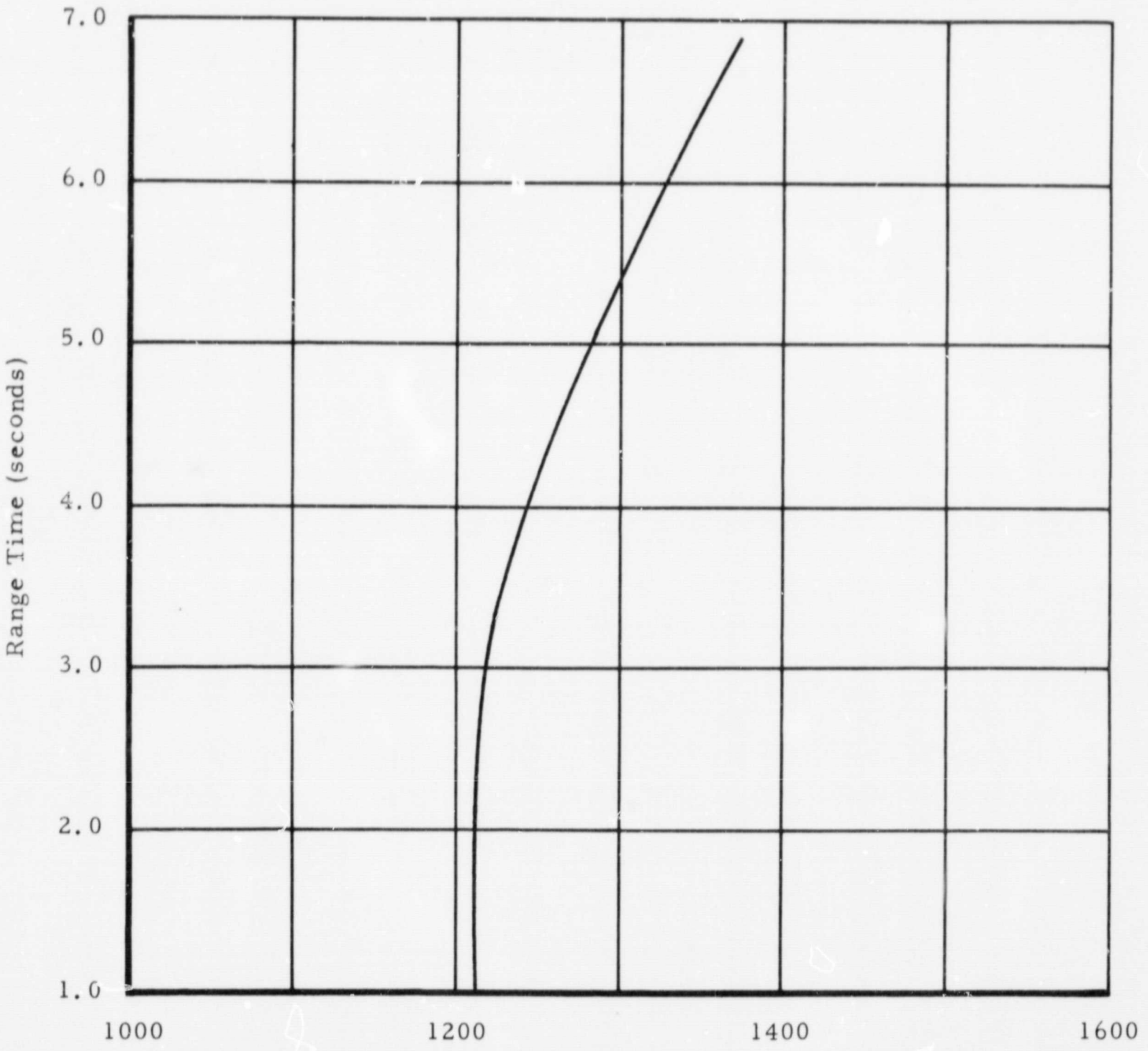


FIGURE 8. VEHICLE LATERAL MOTION
(Distance Between the Centerline of the Vehicle
and the Centerline of the Umbilical Tower)

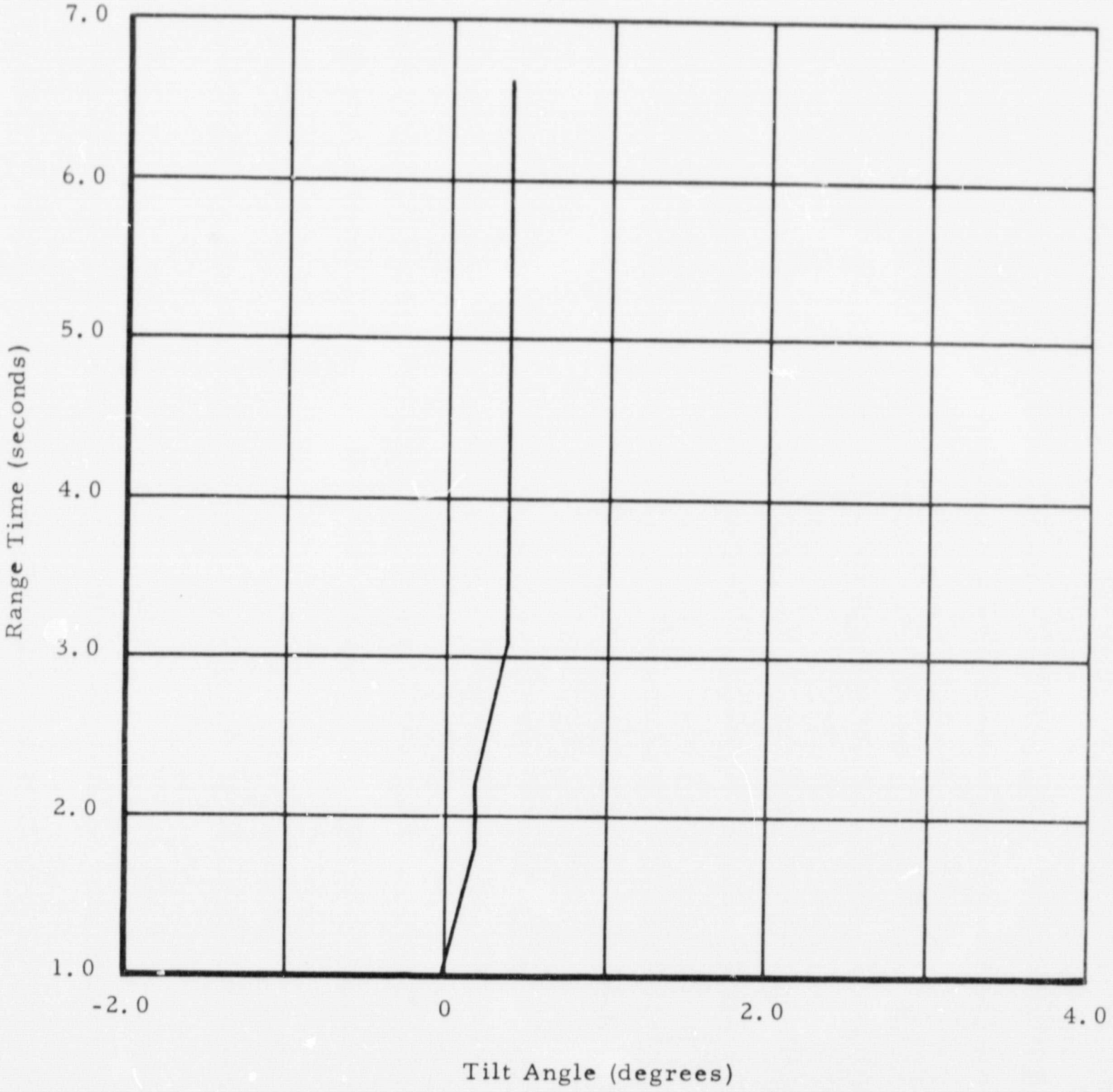


FIGURE 9. VEHICLE TILT ANGLE

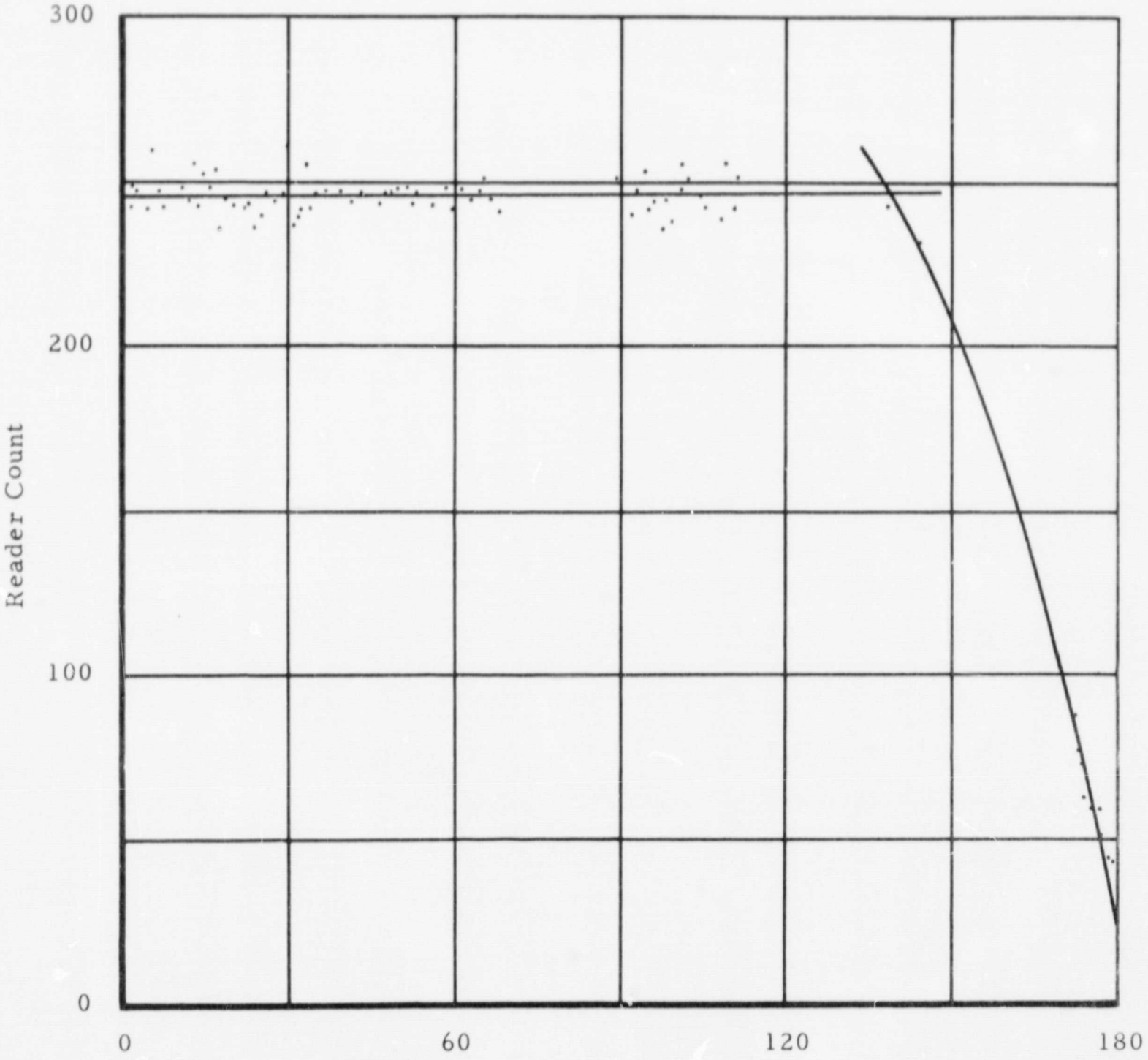


FIGURE 10. HOLDDOWN ARM I RELEASE

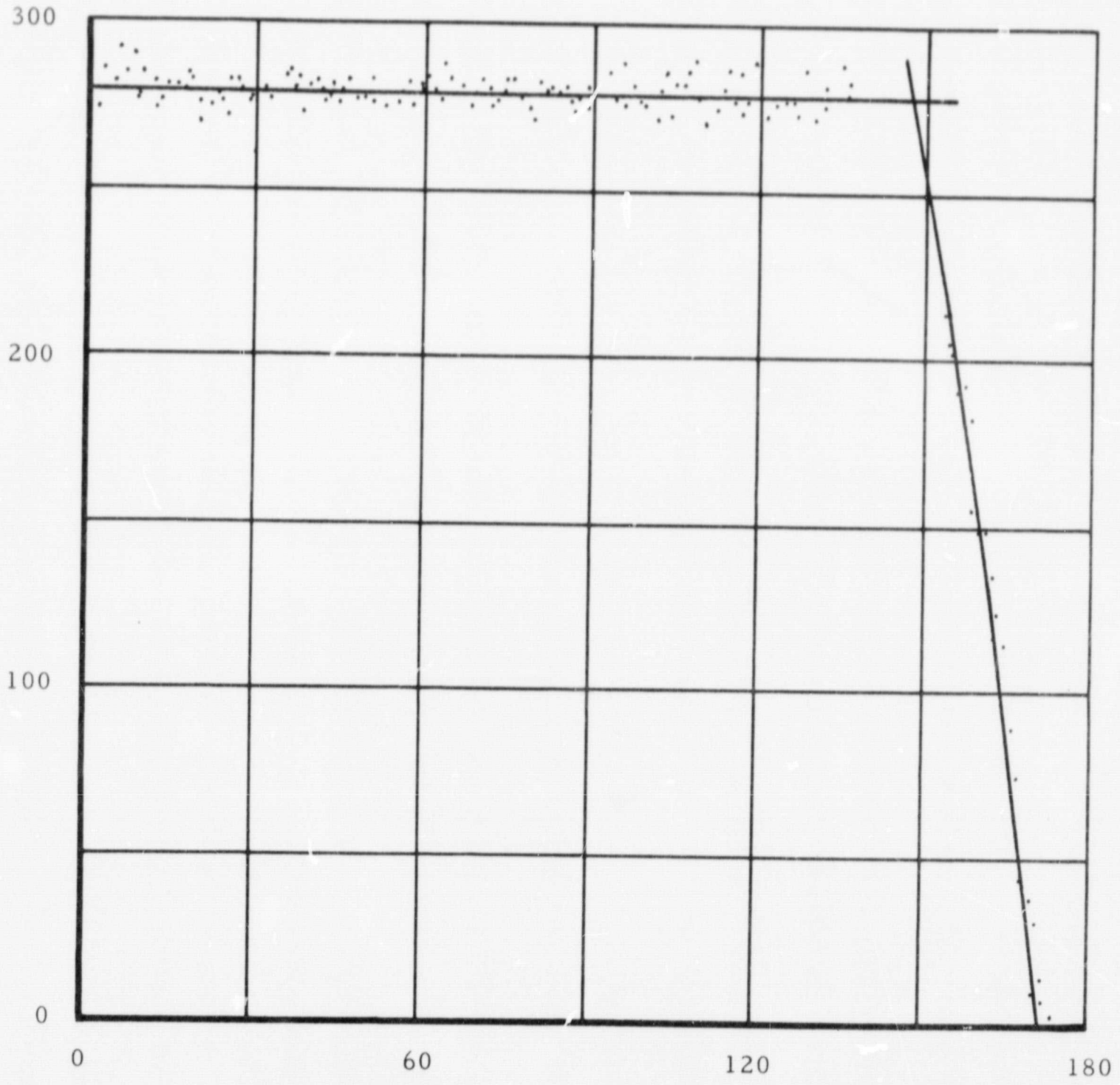


FIGURE 11. HOLDDOWN ARM I-II RELEASE

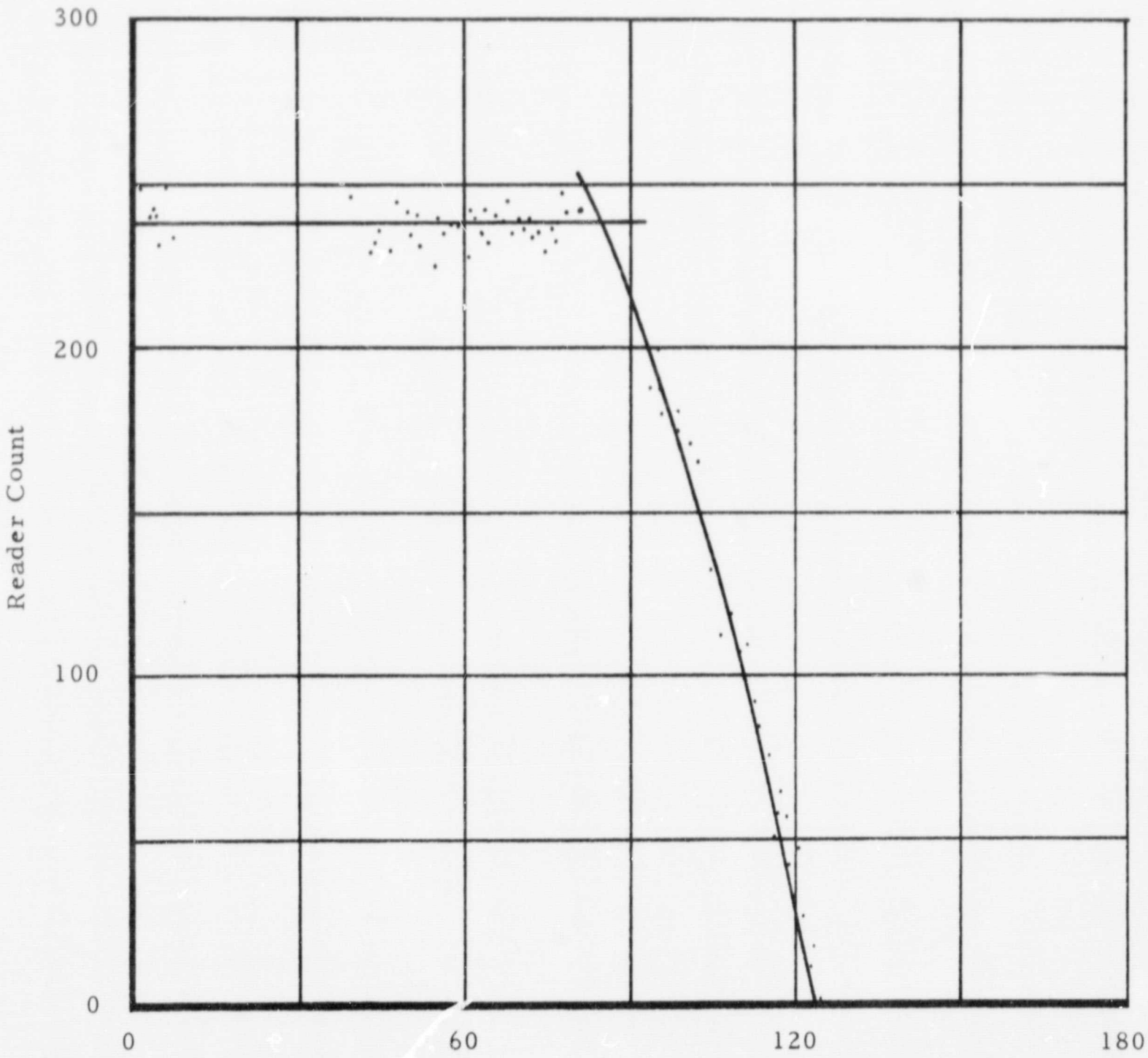


FIGURE 12. HOLDDOWN ARM II RELEASE

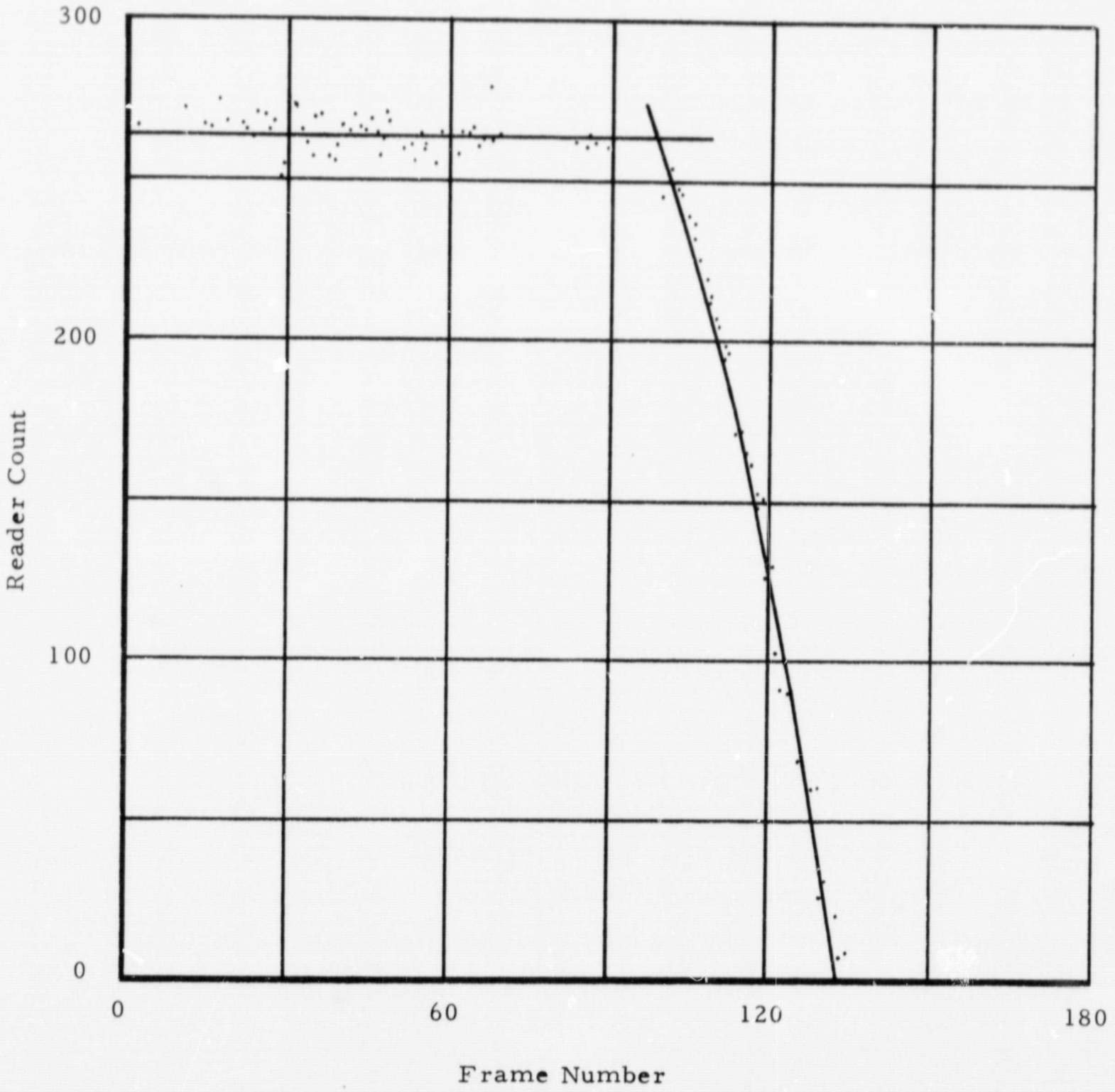


FIGURE 13. HOLDDOWN ARM II-III RELEASE

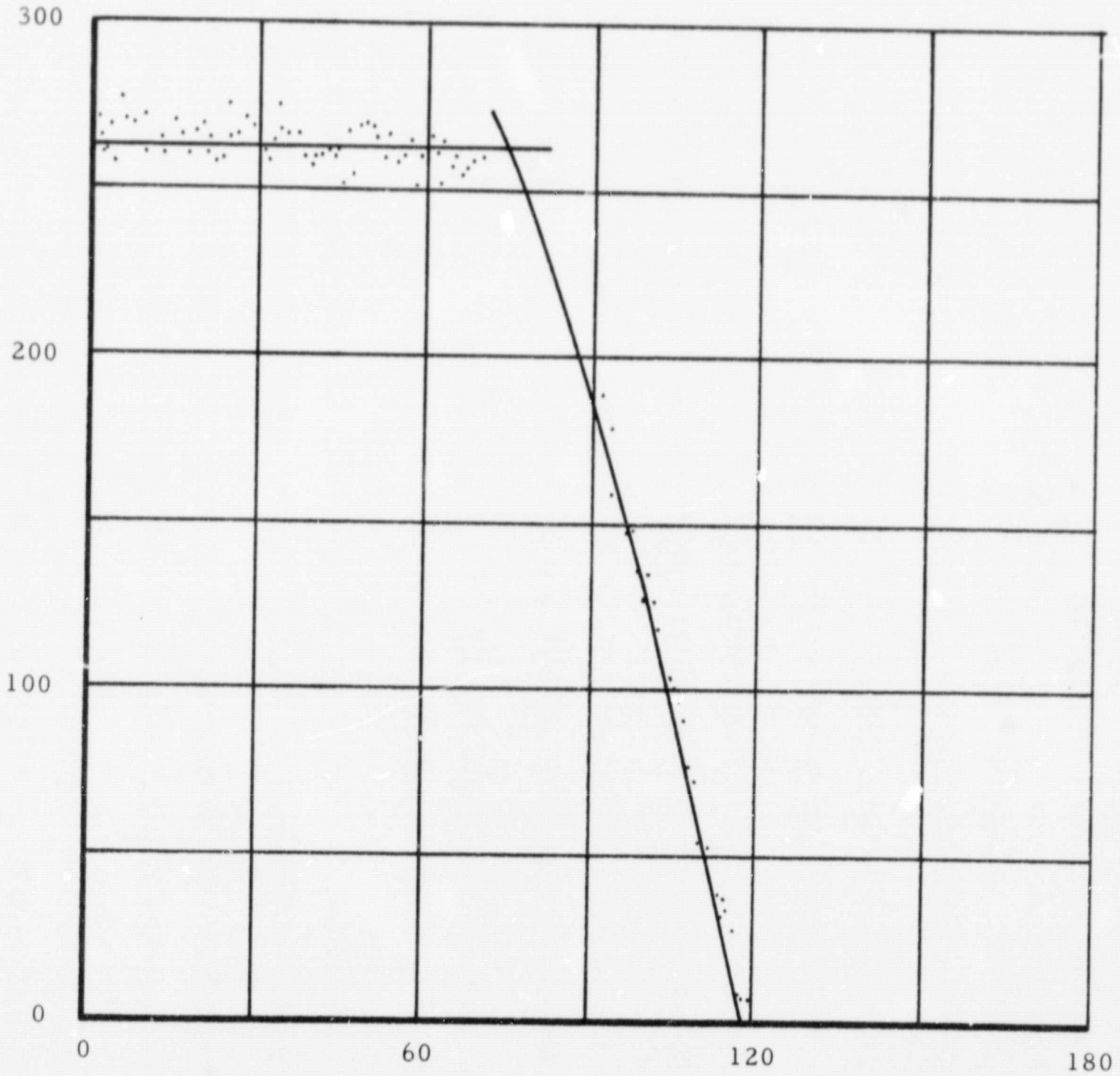


FIGURE 14. HOLDDOWN ARM III RELEASE

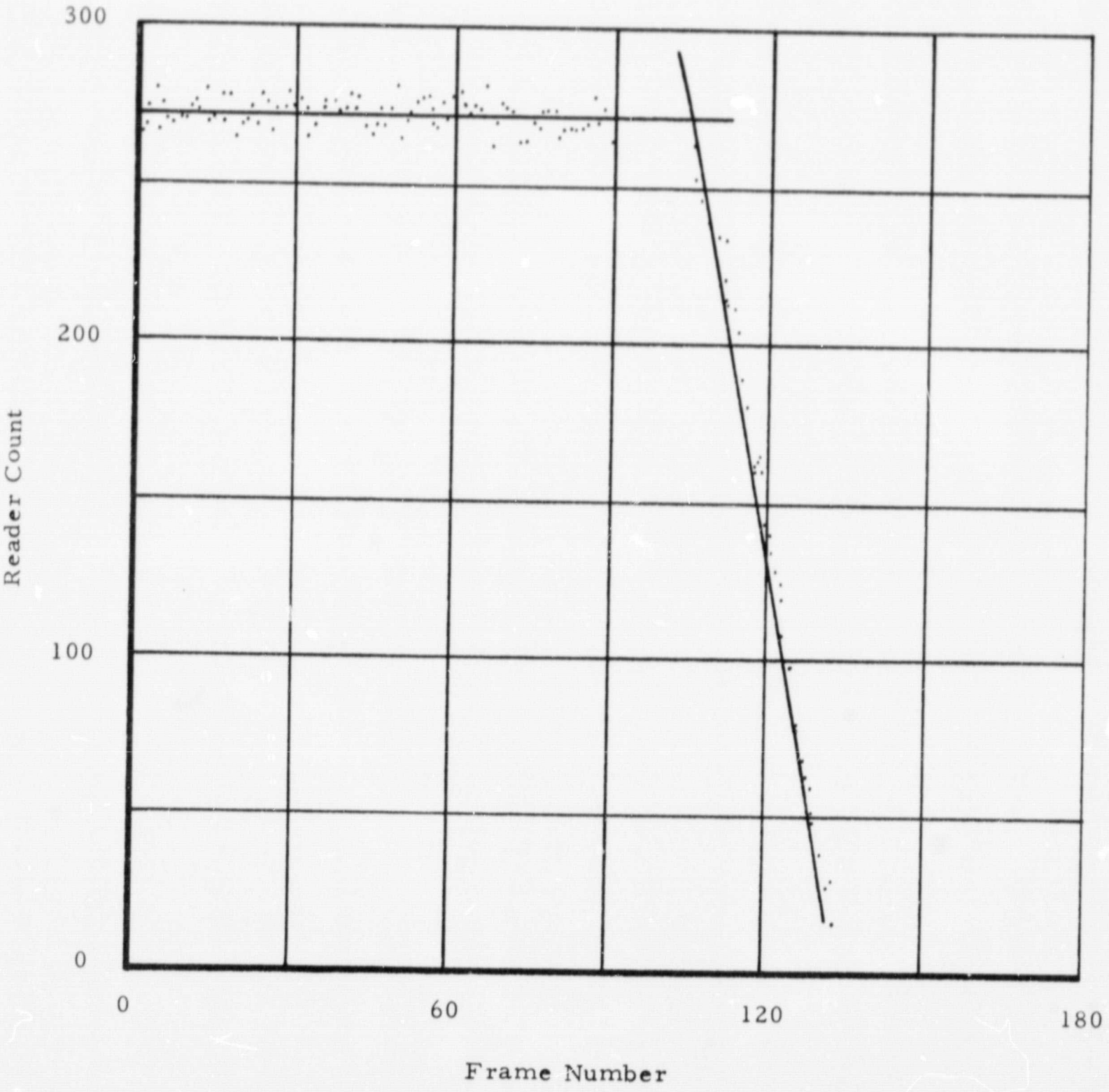


FIGURE 15. HOLDDOWN ARM III-IV RELEASE

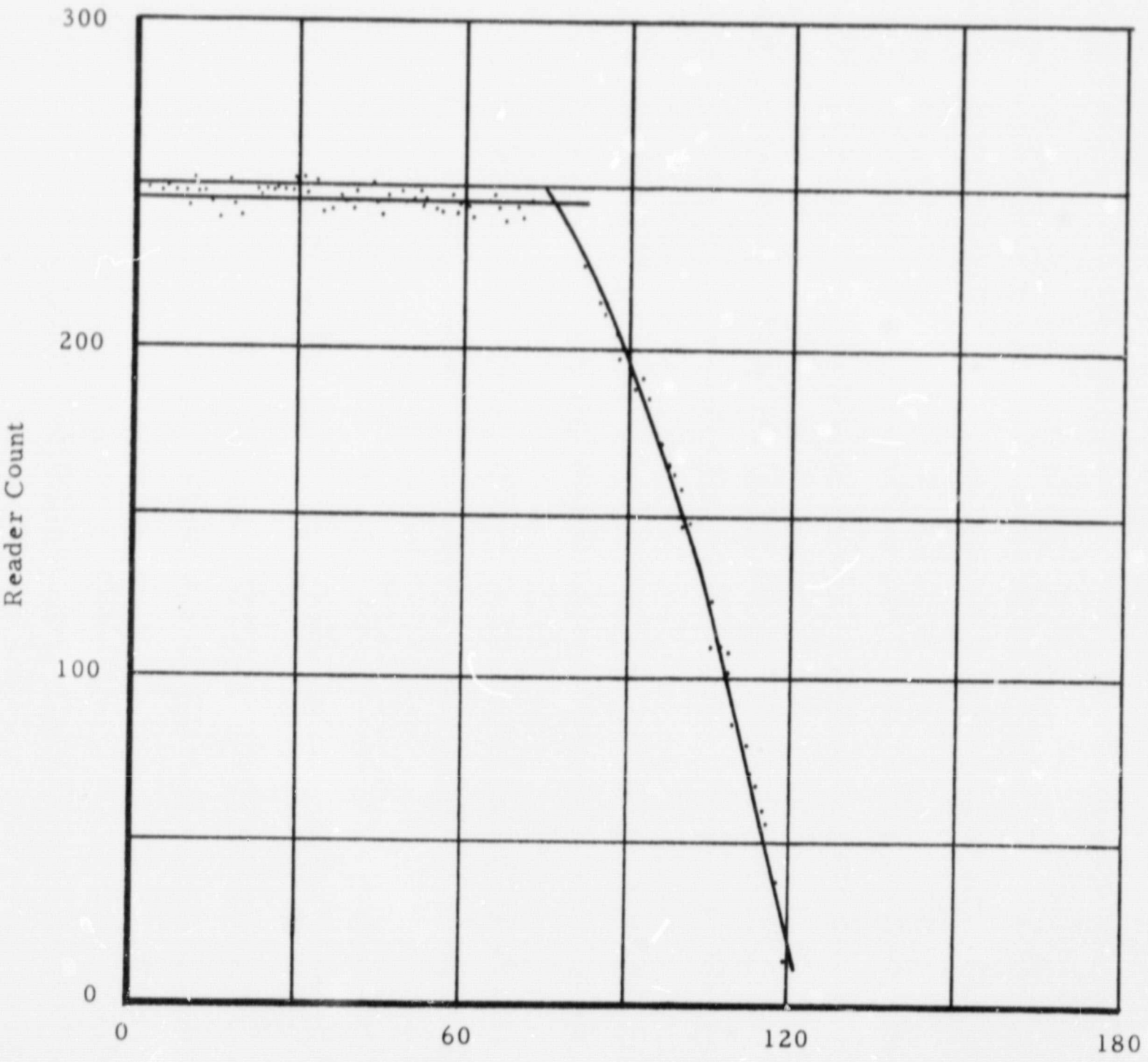


FIGURE 16. HOLDDOWN ARM IV RELEASE

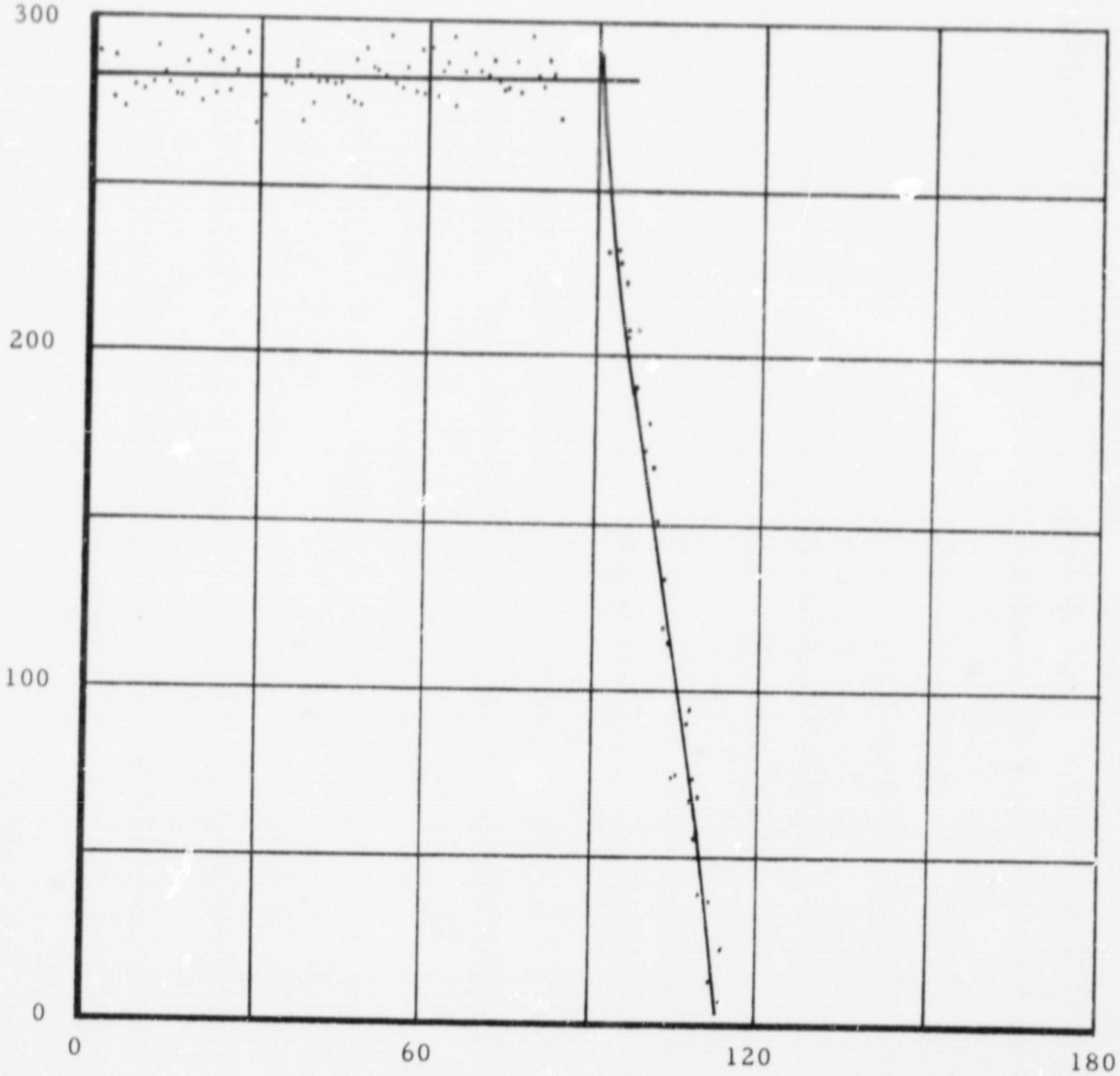


FIGURE 17. HOLDDOWN ARM IV-I RELEASE

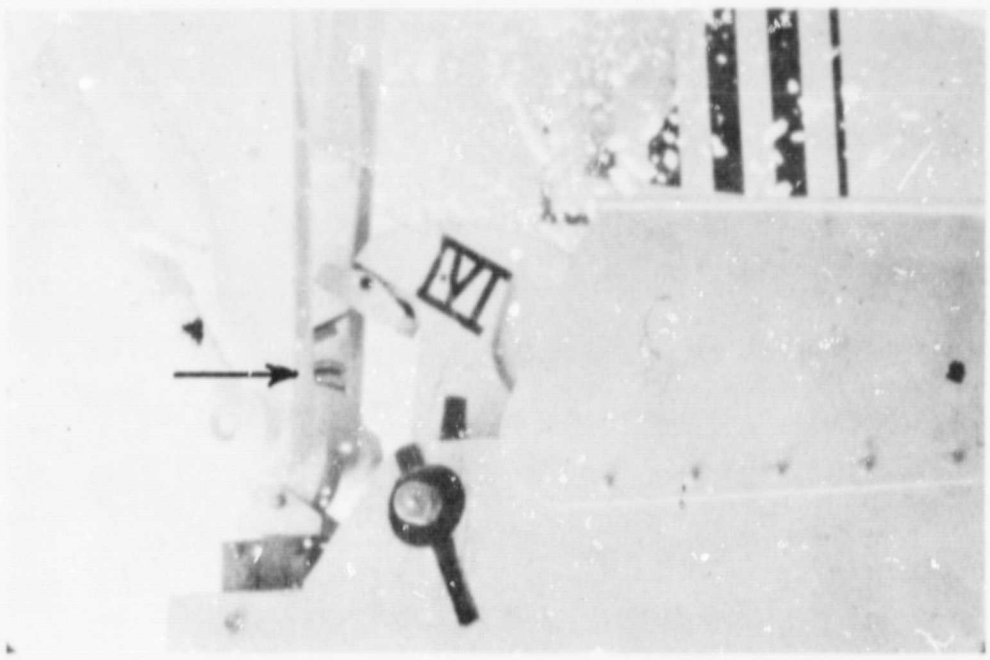


FIGURE 18. HOLDDOWN ARM SHOE ON VEHICLE

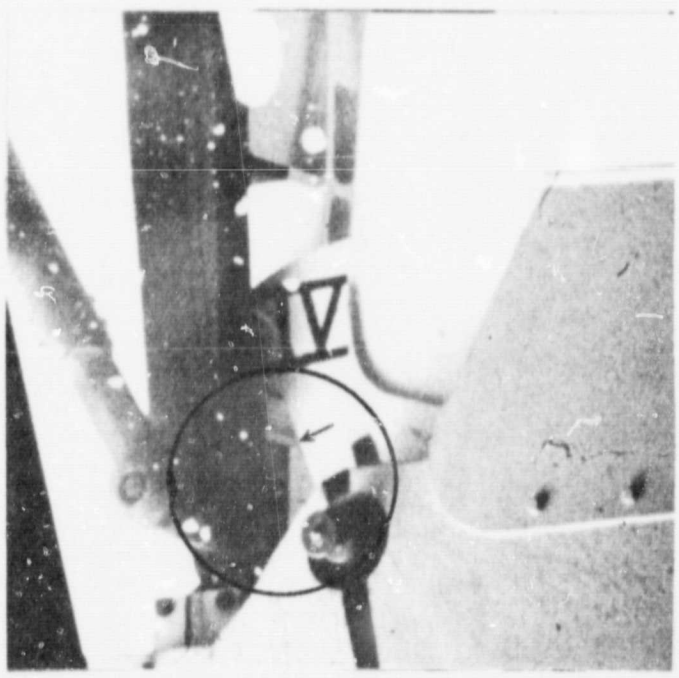


FIGURE 19. VEHICLE SUPPORT STRUT SHIFT HOLDDOWN ARM IV BEFORE

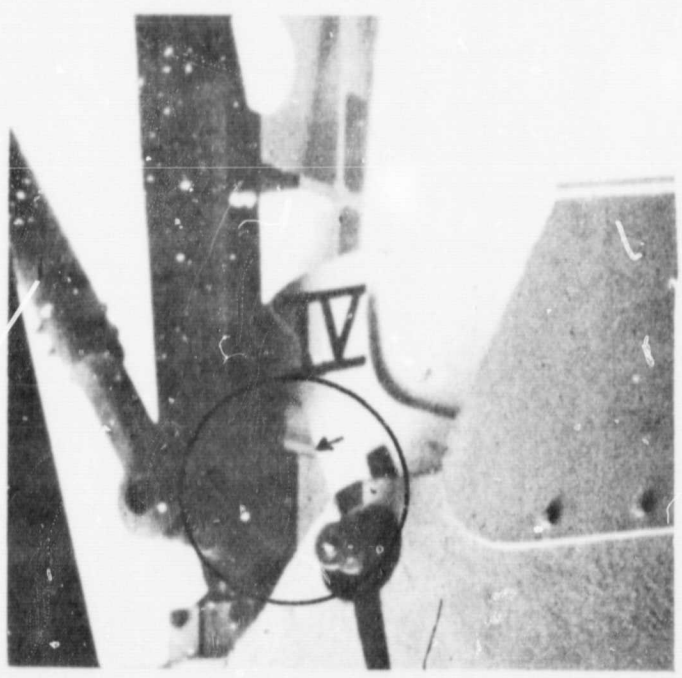


FIGURE 20. VEHICLE SUPPORT STRUT SHIFT HOLDDOWN ARM II AFTER

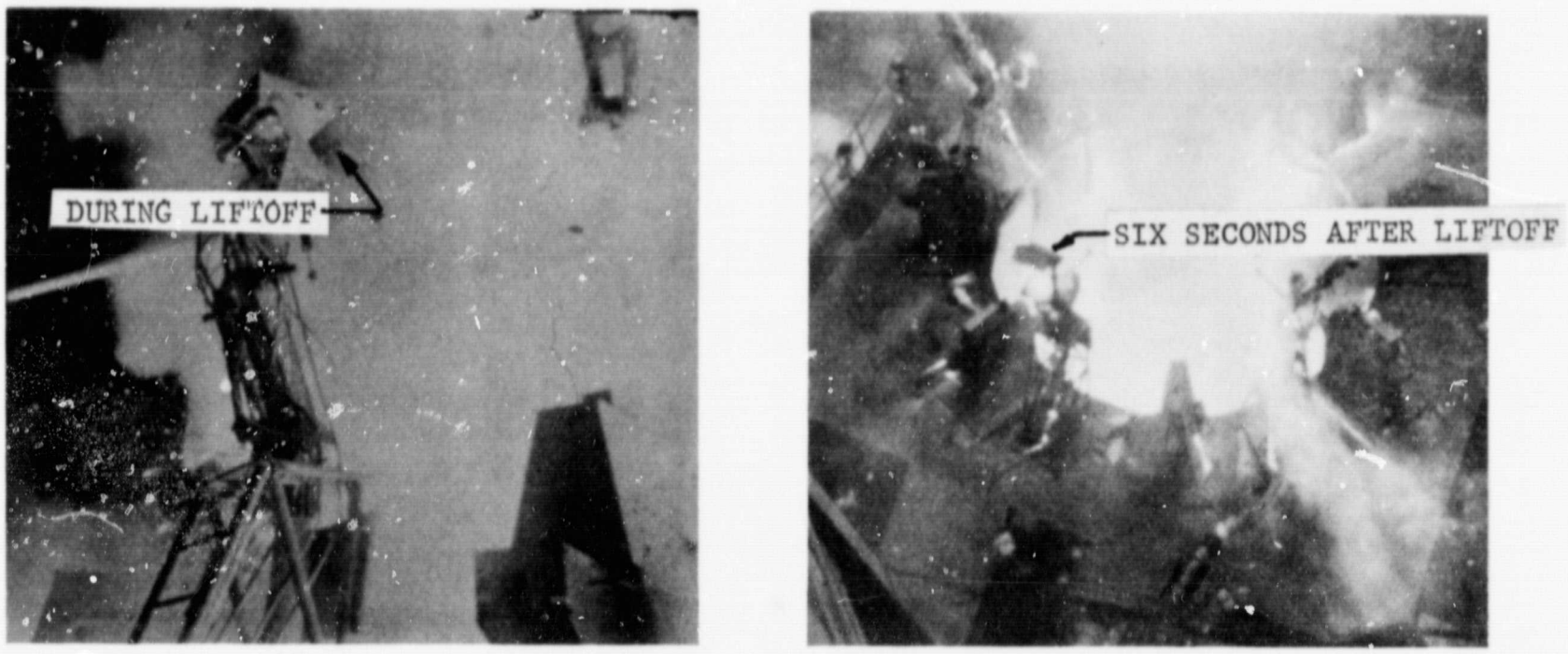


FIGURE 21. SHORT CABLE MAST II DEFLECTOR COVER

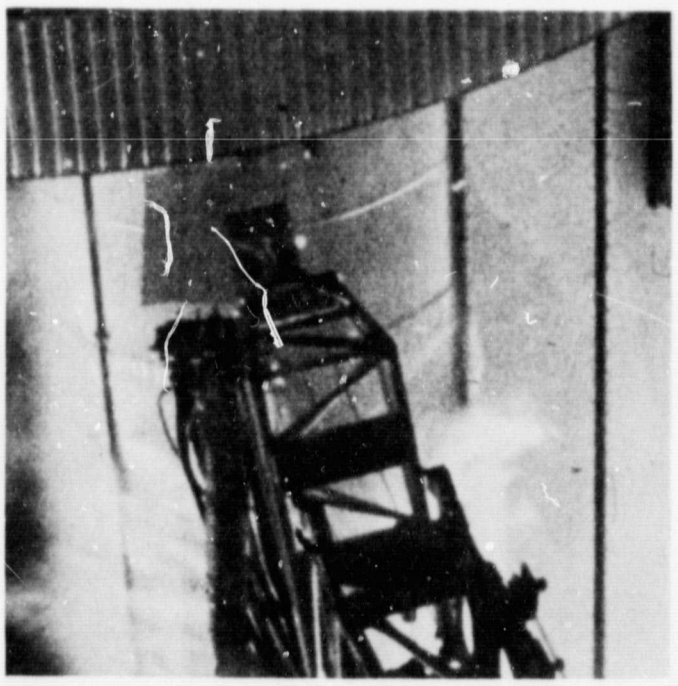
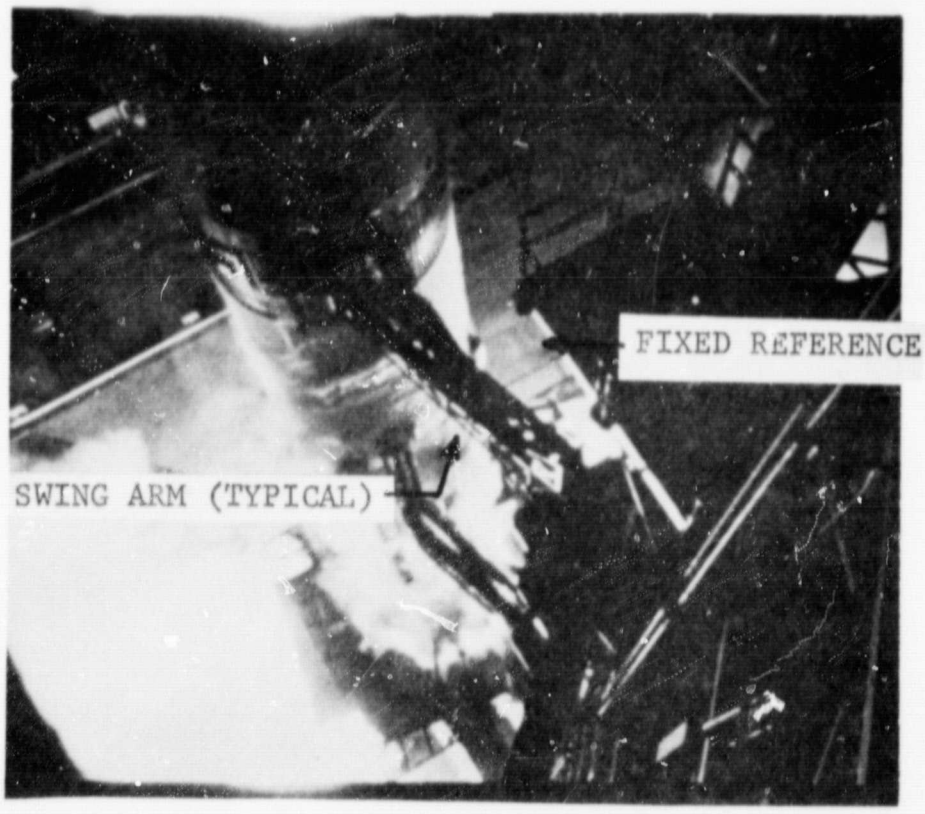


FIGURE 22. TYPICAL SWING ARM DISCONNECT



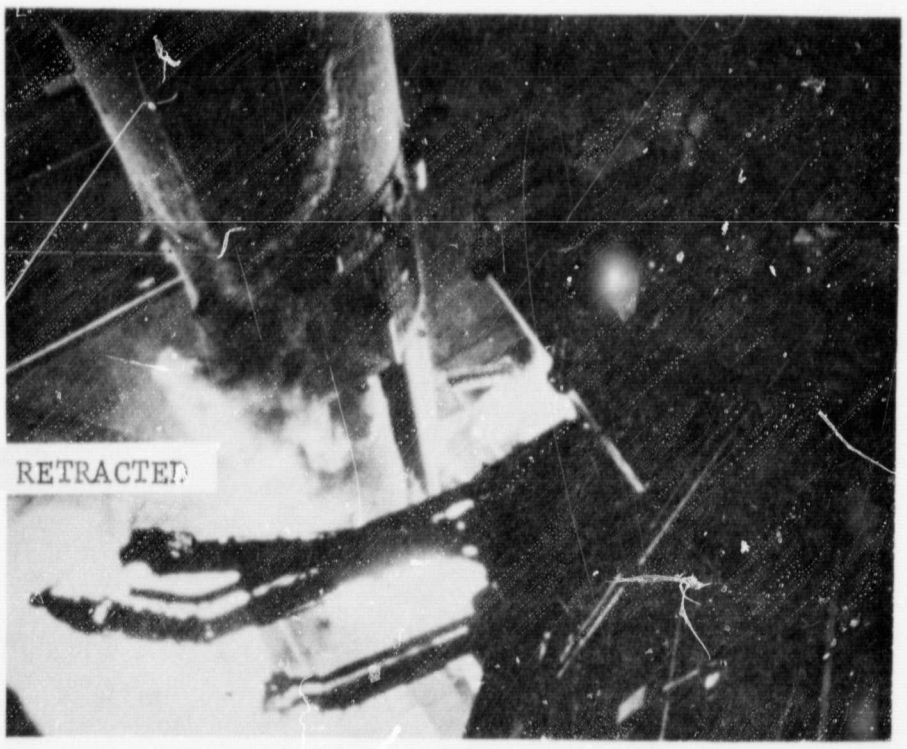


FIGURE 23. SWING ARM RETRACTION RATE

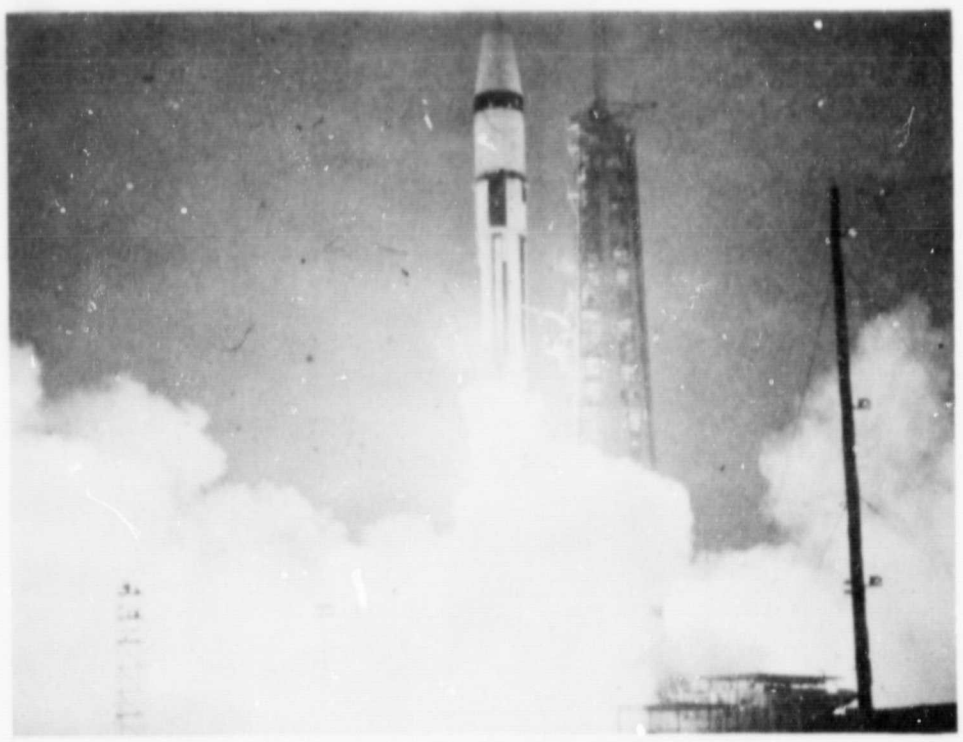


FIGURE 24. VEHICLE/SWING ARM CLEARANCE

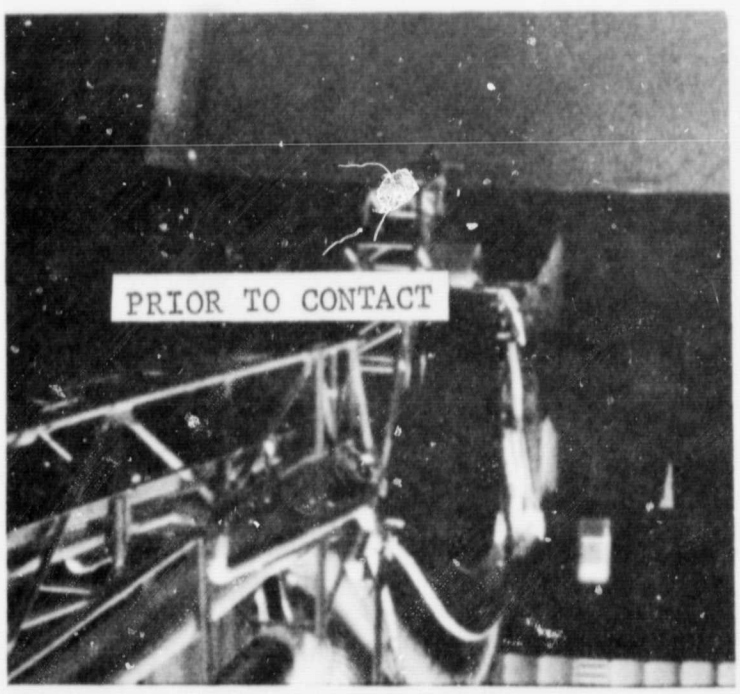


FIGURE 25. SWING ARM #3 CONTACT WITH VEHICLE COVER

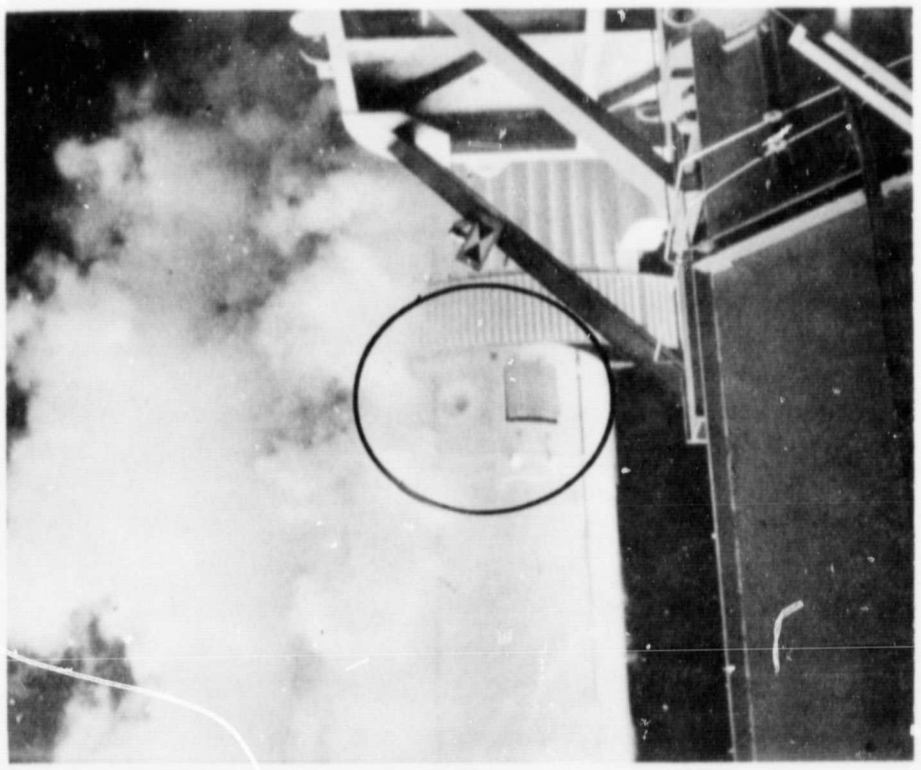


FIGURE 26. SWING ARM #1 TANK COVER PANEL OPEN

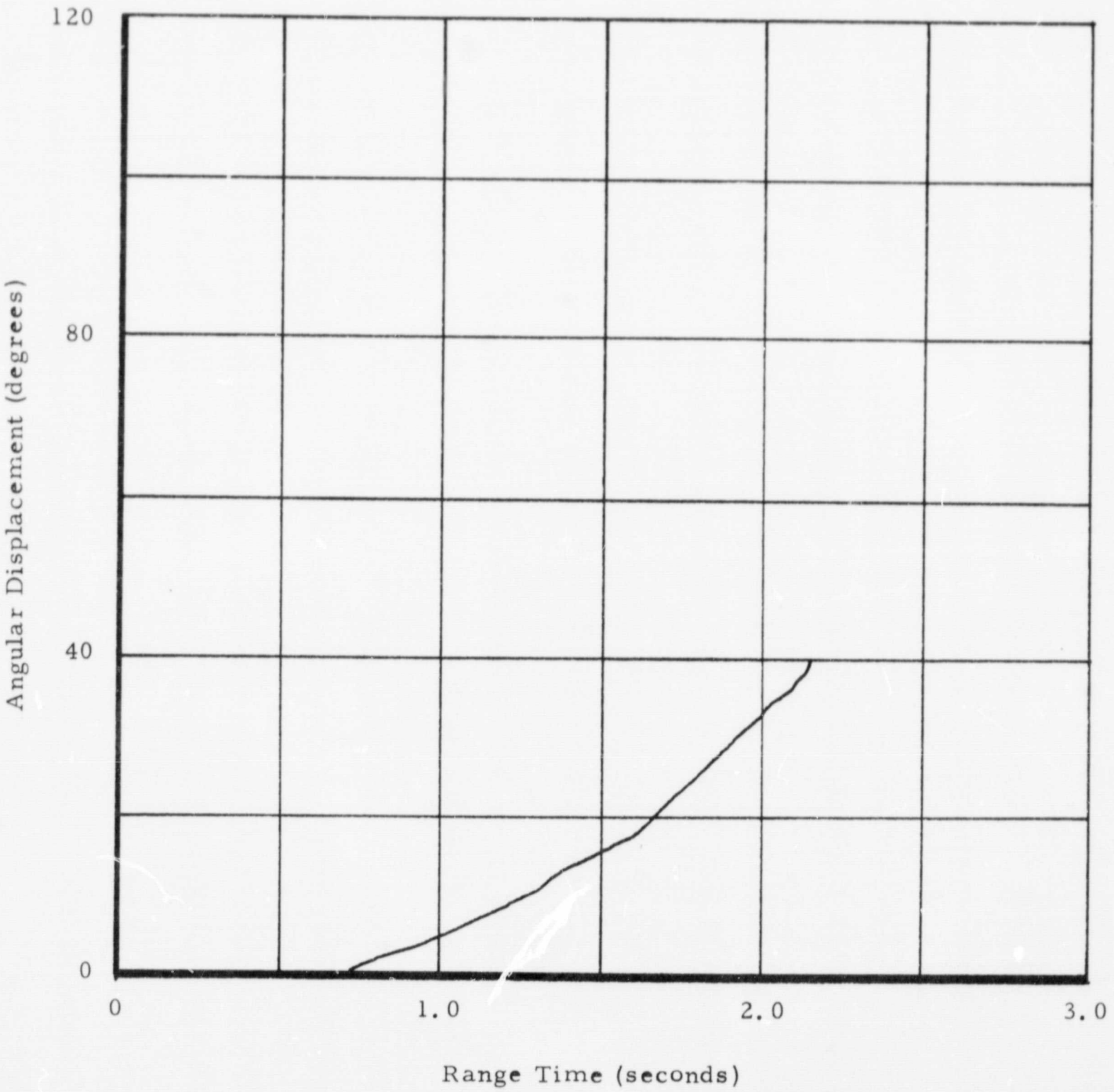


FIGURE 27. SWING ARM #2 DISPLACEMENT

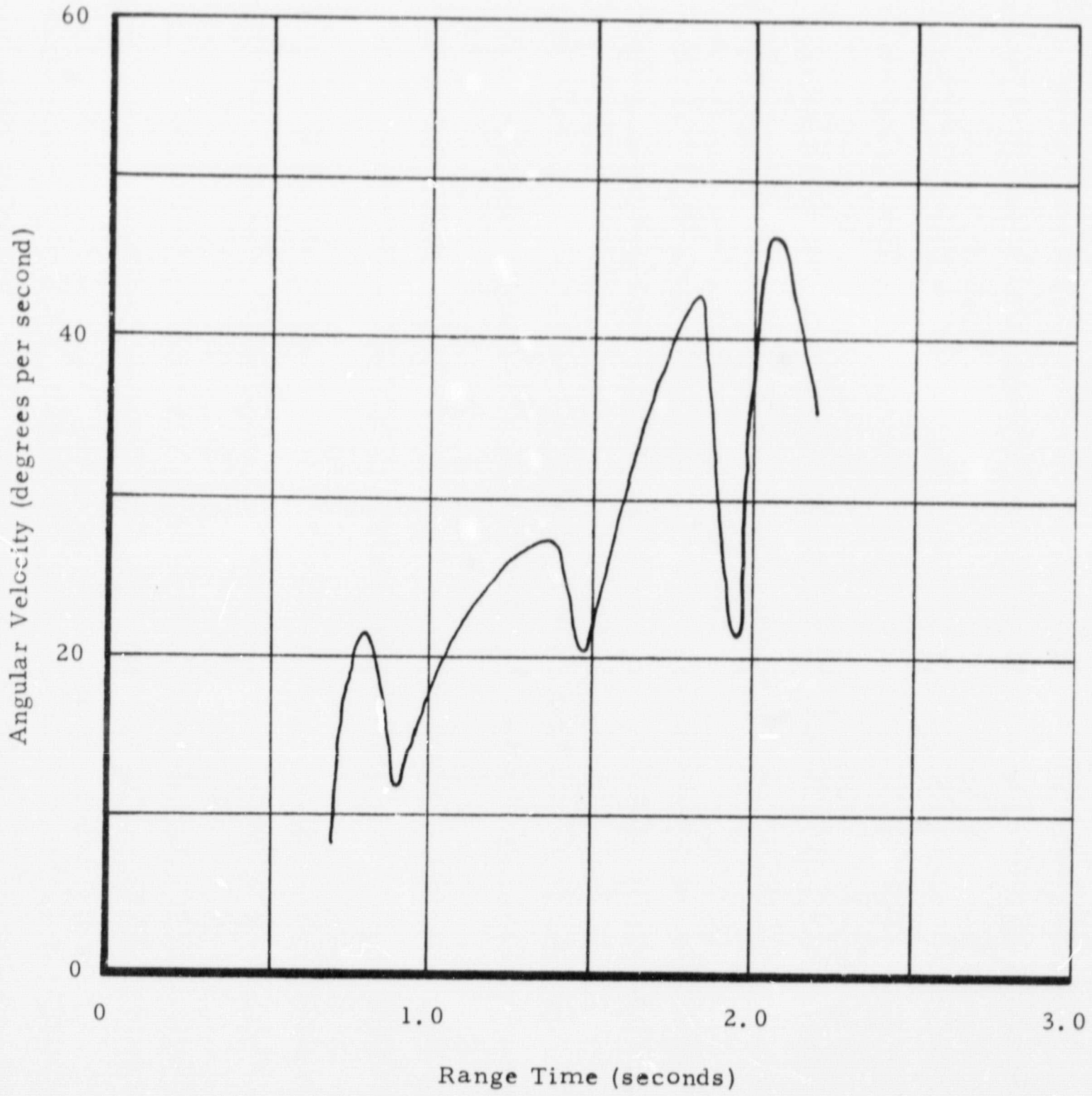


FIGURE 28. SWING ARM #2 ANGULAR VELOCITY

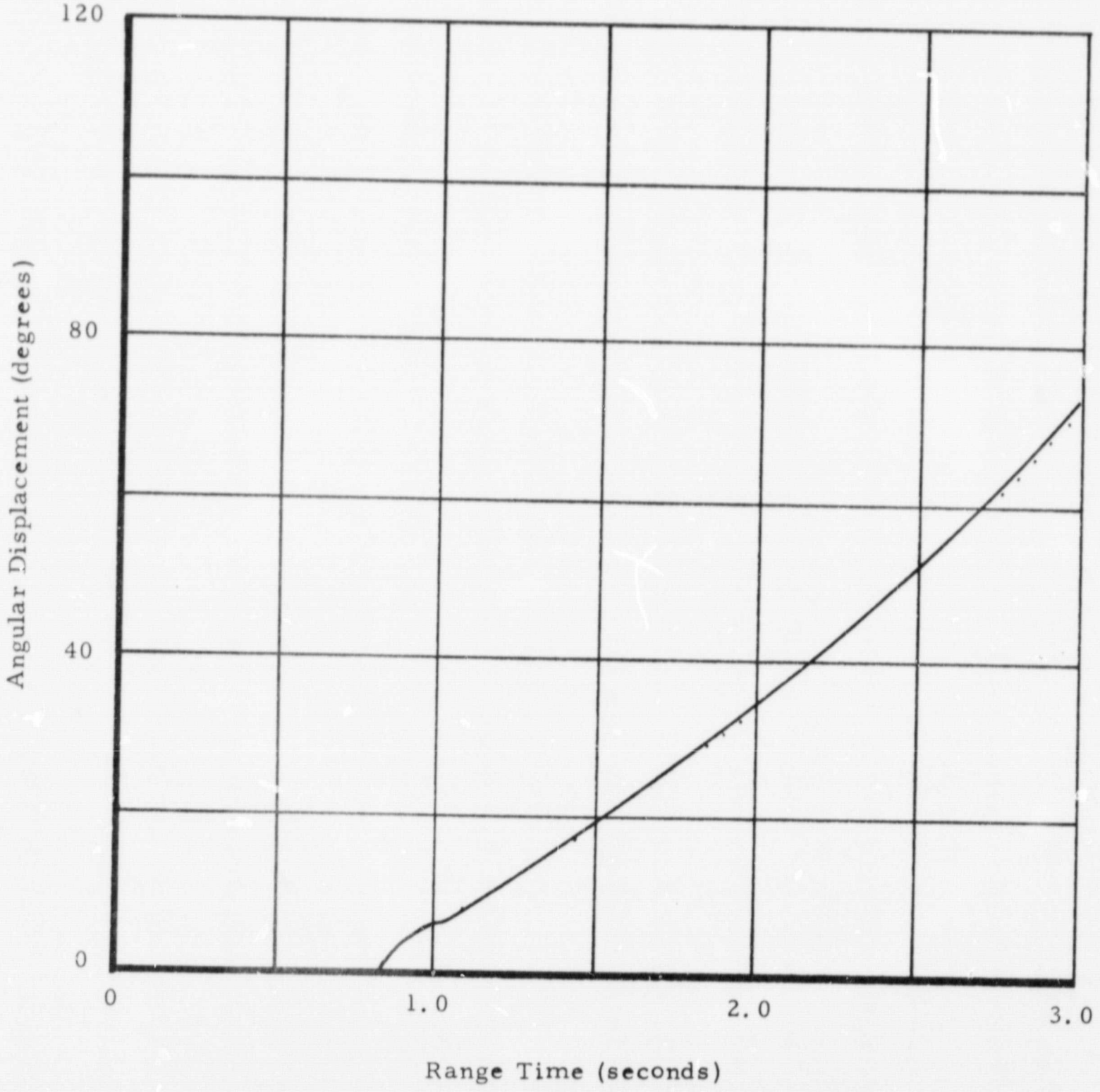


FIGURE 29. SWING ARM #3 DISPLACEMENT

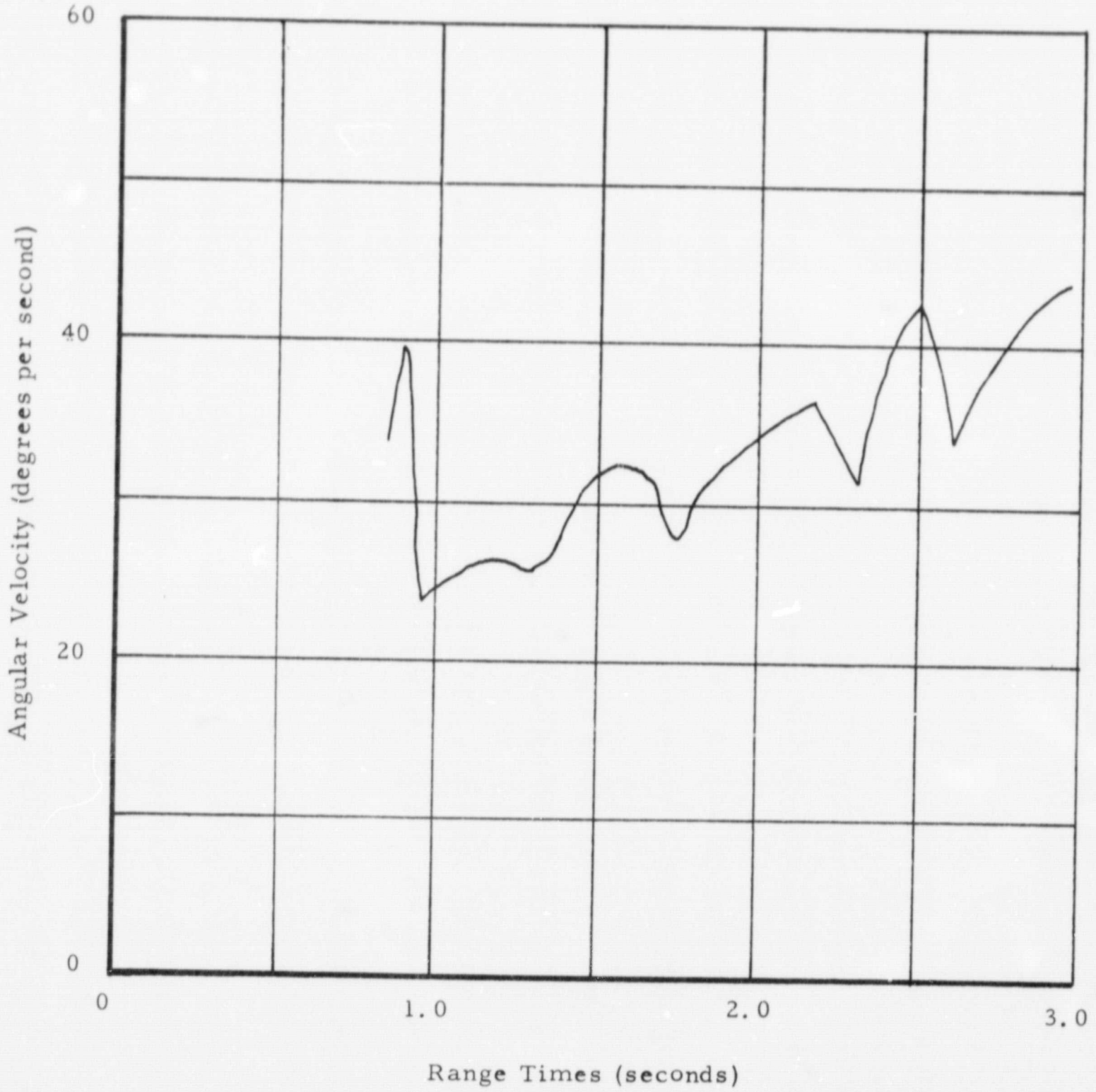


FIGURE 30. SWING ARM #3 ANGULAR VELOCITY

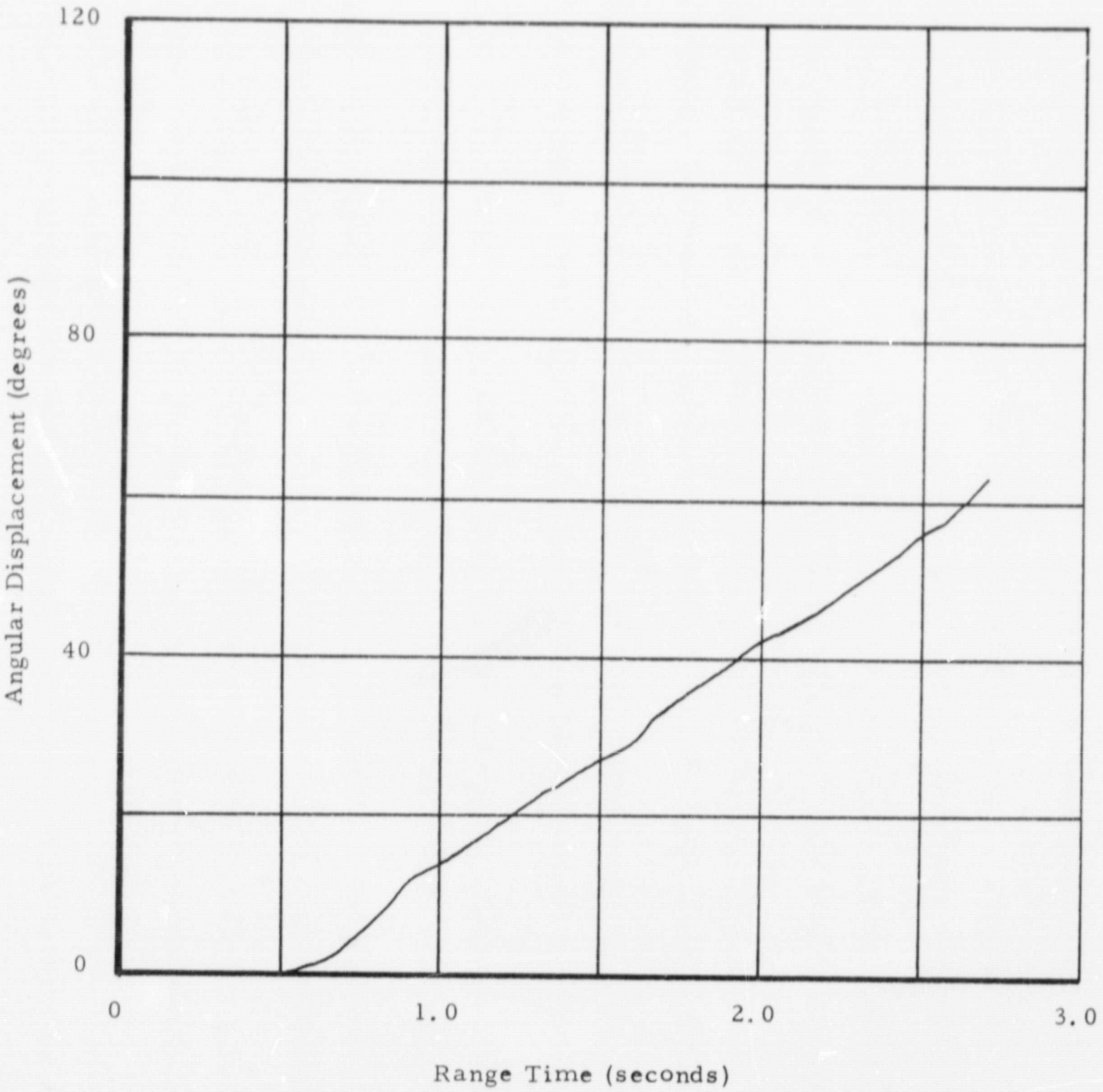


FIGURE 31, SWING ARM #4 DISPLACEMENT

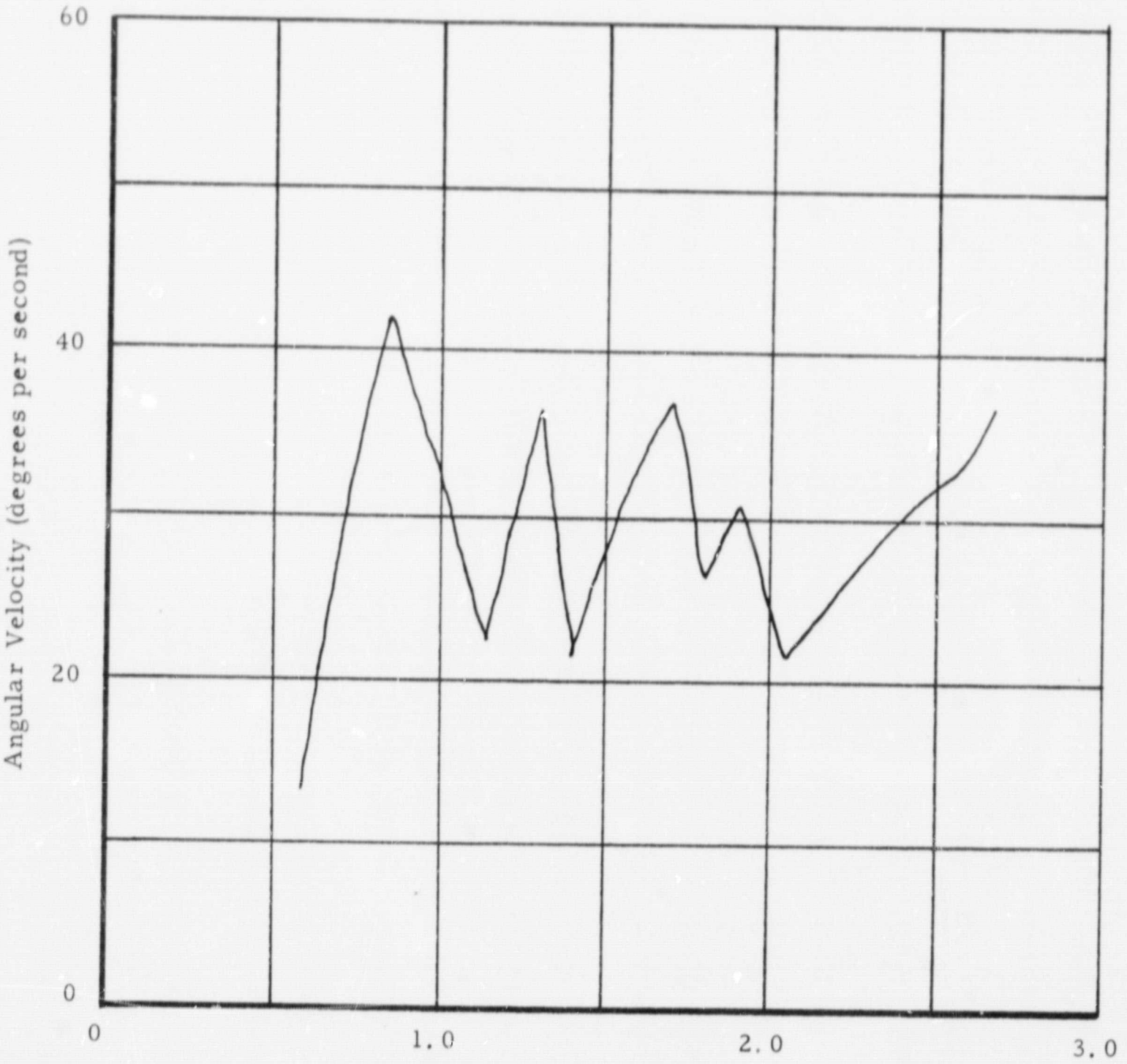


FIGURE 32. SWING ARM #4 ANGULAR VELOCITY

FIGURE 33. BLAST AND FLAME ON LAUNCH PEDESTAL

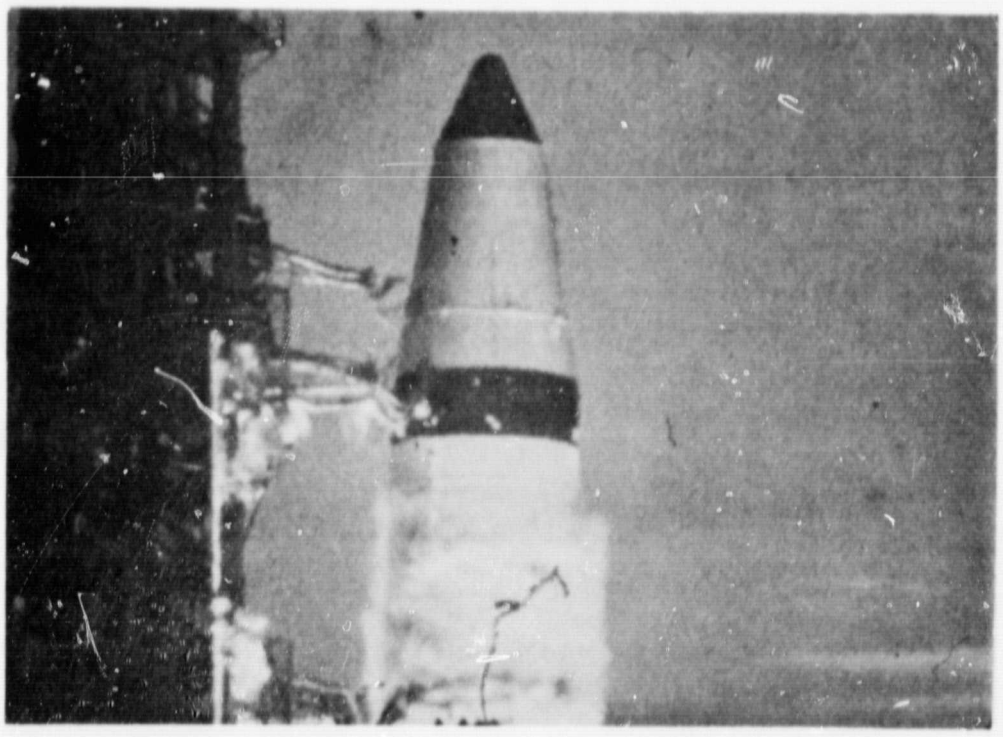


FIGURE 34. S-IVB FROST AND ICE ACCUMULATION

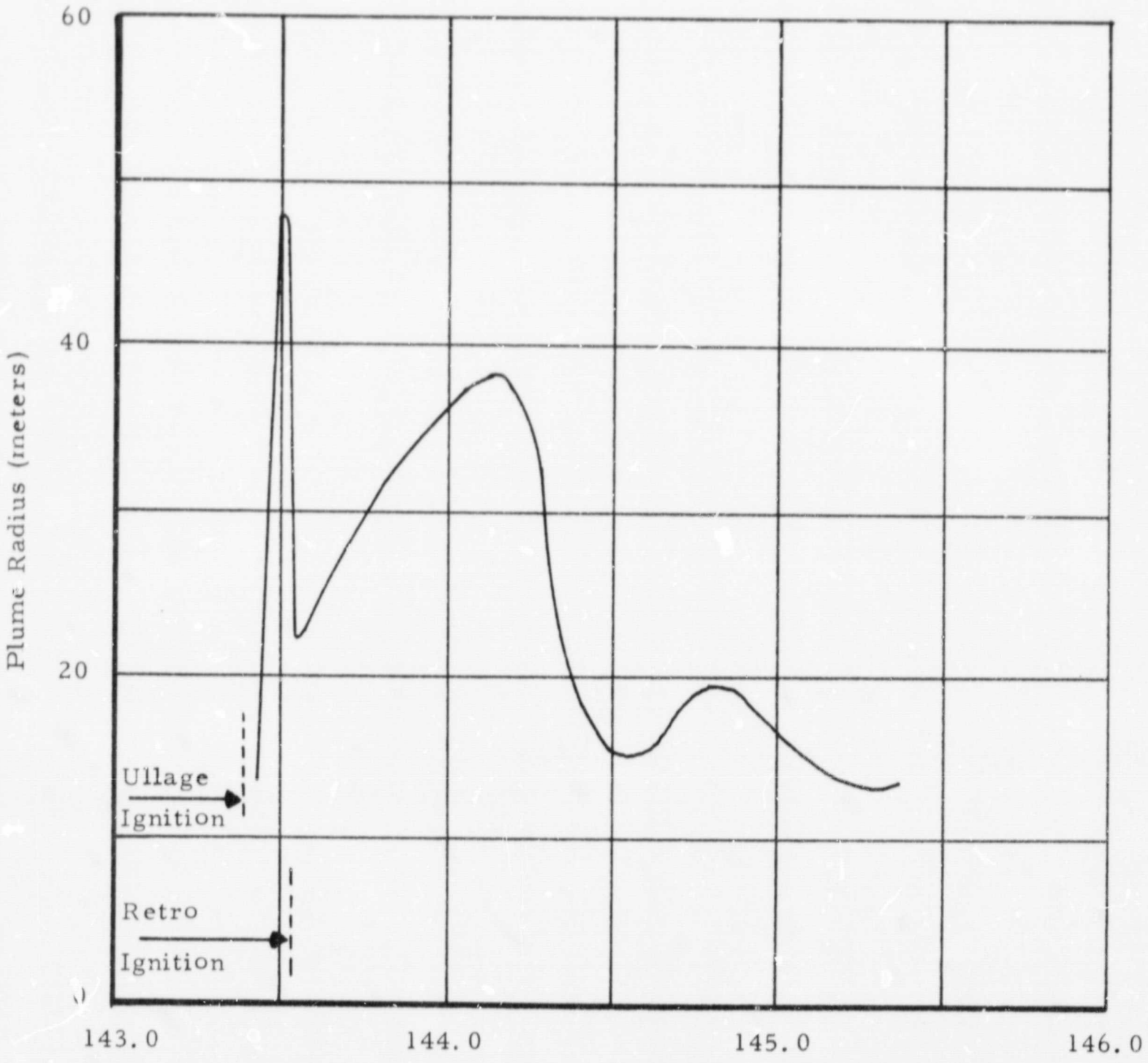
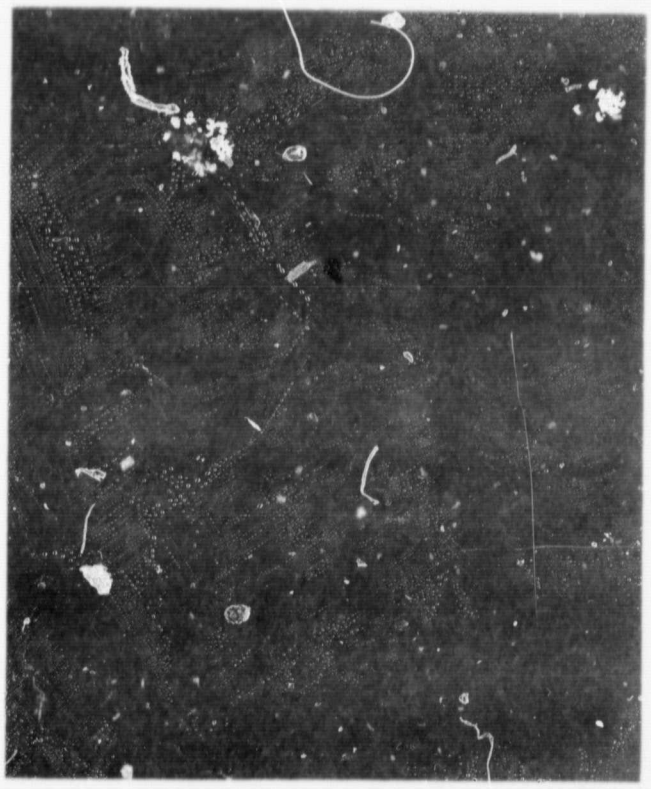
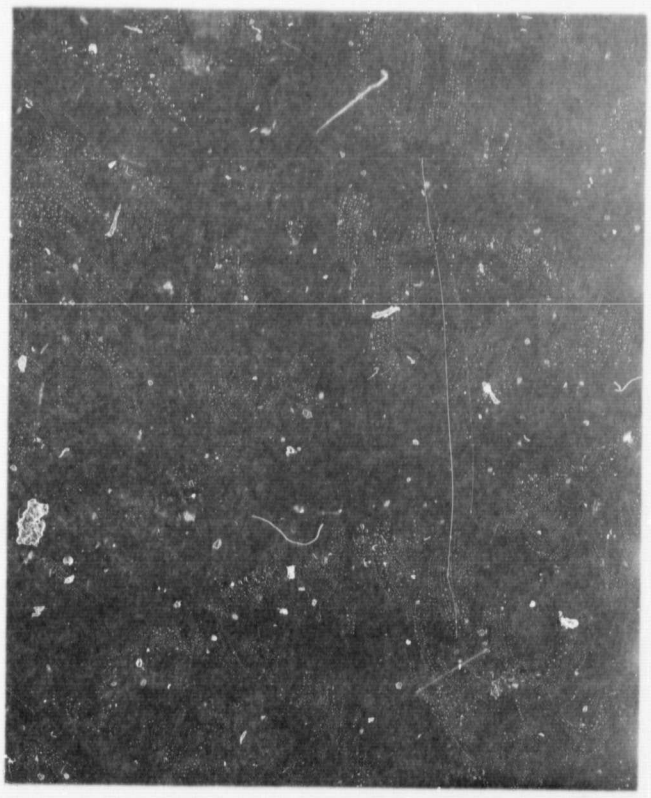


FIGURE 35. RETROROCKET EXHAUST PLUME

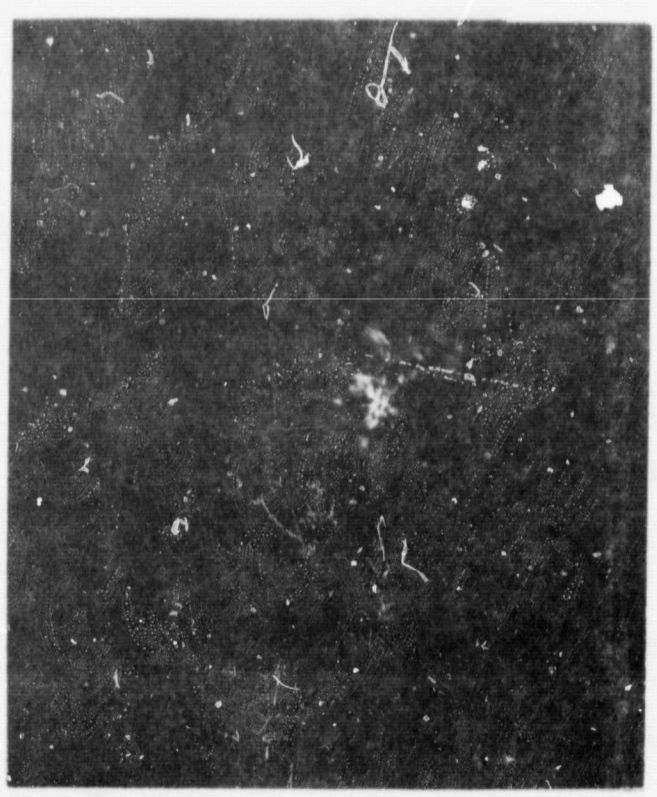


IECO

Flare Up



OECO



Retro Rocket Ignition

FIGURE 36. S-IB/S-IVB SEPARATION SEQUENCE

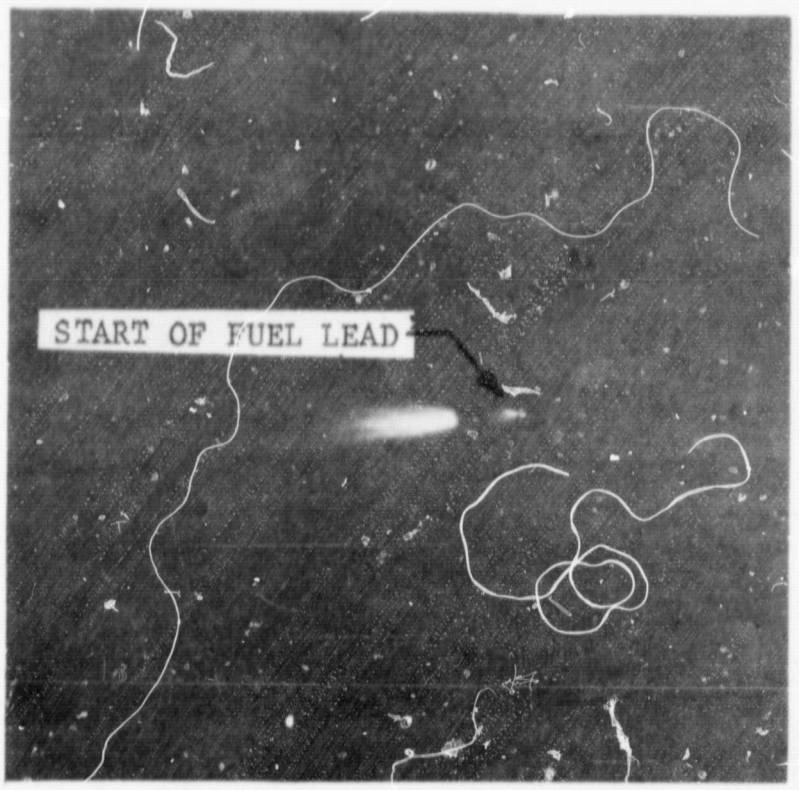


FIGURE 32. J-2 ENGINE IGNITION SEQUENCE

APPENDIX B. QUALITY ASSESSMENT OF SA-204/LM-1 ESCC FLIGHT FILM

Each item of coverage obtained by photo/optical instrumentation was reviewed. The available data provided sufficient coverage and was of excellent quality.

The review included a quality assessment of each item. The primary factors assessed were orientation, focus, and exposure. Each camera was assigned an object (vehicle, GSE, swing arm, etc.) and from this assignment the required orientation was determined. In most cases the format and orientation (as specified in the Program Support Requirements Document) was designed for maximum use of the entire field of view by covering other areas of interest in addition to the primary object. Comments on desired camera orientation versus actual camera orientation are included. All camera frame rates are in frames per second.

Each camera is also programmed to obtain coverage for a specified duration of time during the launch sequence. The required coverage by some of the cameras located near the vehicle were partially obscured by smoke, flame, and/or falling ice. This coverage can only be compared with the results of previous tests; and if feasible, relocation of cameras is considered. It is noted that much of the smoke, frost and ice interference is a function of launch weather conditions and cannot be corrected by camera relocation. Optimum location of cameras is also hindered by physical limitations of the supporting facilities.

In those cases of camera malfunctions and other anomalies, remedial action has been initiated by coordination between Chrysler Corporation Space Division, Marshall Space Flight Center, and Kennedy Space Center.

A detailed item assessment of each camera programmed for this launch is presented.

APPENDIX B. (CONTINUED)

Item	Location	Type	Focal Length	Frame Rate	Focus	Exposure	Orientation	Field of View	Time Frame Reference	Coded Range Time
E-1	37-1	35mm MIT	50mm	96	Good	Good	Good	Good	Usable	Usable

Required Orientation: Center bottom of launch pedestal in bottom of frame for study of vehicle motion, structural surveillance, and engine start sequence.
Comments: Engine start sequence was observed. Tower clearance was timed. Film was used to determine vehicle lateral motion. Water quench system operation was observed.

E-5	37-1	70mm P/S	80mm	30	---	---	---	---	---	---

Required Orientation: Center tip of nose cone in bottom of frame for study of vehicle motion and engine operation during first three vehicle lengths of flight.
Comments: Camera failed to operate.

E-6	37-2	70mm P/S	80mm	30	Good	Good	Good	Good	Usable	Usable

Required Orientation: Center tip of nose cone in bottom of frame for study of vehicle motion and engine operation during first three vehicle lengths of flight.
Comments: Vehicle obscured by exhaust smoke during entire lift-off sequence.

APPENDIX B. (CONTINUED)

Item	Location	Type	Focal Length	Frame Rate	Focus	Exposure	Orientation	Field of View	Time Frame Reference	Coded Range Time
E-7	37-3	70mm P/S	80mm	30	Good	Good	Good	Good	Usable	Usable

Required Orientation: Center tip of nose cone in bottom of frame for study of vehicle motion and engine operation during first three vehicle lengths of flight.
Comments: Camera operated as programmed. No malfunctions were observed.

E-8	37-4	70mm P/S	80mm	30	Good	Good	Good	Good	Unusable	Usable

Required Orientation: Center tip of nose cone in bottom edge of frame for study of vehicle motion and engine operation during first three vehicle lengths of flight.
Comments: Camera operated as programmed. No malfunctions were observed.

E-10	37-2 50' Twr	35mm MIT	6 in	96	Good	Good	Good	Good	Usable	Usable

Required Orientation: Center top of launch pedestal in bottom edge of frame for structural surveillance of the S-IB during vehicle ignition and lift-off.
Comments: Camera operated as programmed. No malfunctions were observed. The start of water quench was not visible at the end of the film.

APPENDIX B. (CONTINUED)

Item	Location	Type	Focal Length	Frame Rate	Focus	Exposure	Orientation	Field of View	Time Frame Reference	Coded Range Time
E-12	37-4 30' Twr	35mm MIT	6 in	96	Good	Good	See Note	Good	Usable	Usable

Required Orientation: Center top of launch pedestal in bottom of frame for structural surveillance of the S-IB stage during vehicle ignition and lift-off.

Comments: The camera orientation was incorrect; however, no data were lost. The camera should have the S-IB stage centered in the frame during lift-off. No malfunctions were observed.

E-13	75° 375' 50' Twr	35mm FAX	6 in	500	Good	Good	Good	Good	Usable	Usable

Required Orientation: Center bottom one-fourth of the S-IB stage in frame for detailed study of vehicle motion during lift-off.

Comments: Camera started at engine ignition. Smoke obscures field of view during and after lift-off. No malfunctions were observed.

E-15	245° 375' Top of Blockhouse	35mm	6 in	1000	Good	Good	Good	Good	Usable	Usable

Required Orientation: Center bottom one-fourth of the S-IB stage in frame for detailed study of vehicle motion during lift-off.

Comments: Considerable camera motion was observed at ignition. Excellent coverage of the S-IB stage as programmed. No malfunctions were observed. Excellent coverage of flame impingement on GSE after lift-off.

APPENDIX B. (CONTINUED)

Item	Location	Type	Focal Length	Frame Rate	Focus	Exposure	Orientation	Field of View	Time Frame Reference	Coded Range Time
E-21	Launcher Position 1	16mm MILL	50mm	400	Good	Good	Good	Good	Usable	Usable

Required Orientation: Holddown arm I-II release jaw centered in right half of frame for study of holddown arm release action. Holddown arm is located at 45° AZ. T.
Comments: Wire observed falling from vehicle. Camera case loosened after lift-off. Excellent coverage of the release. Release was timed.

E-22	Launcher Position 2	16mm MILL	40mm	400	Good	Good	Good	Good	Usable	Usable

Required Orientation: Holddown arm II release jaw centered in left half of frame for study of holddown arm release action. Holddown arm II is located at 0° AZ. T.
Comments: Coverage of the release was good. Part of the shoe remains with the vehicle. Some flame and blast impingement upon the LOX mast was observed. Some lateral motion of the vehicle arm was observed.

E-23	Launcher Position 4	16mm MILL	50mm	400	Good	Good	Good	Good	Usable	Usable

Required Orientation: Holddown arm IV-I release jaw centered in right half of frame for study of holddown arm release action. Holddown arm IV-I is located at 135° AZ. T.
Comments: Excellent coverage of release and retraction sequence. Part of the shoe remains with the vehicle. Good coverage of flame and blast on short cable mast IV was obtained. Camera case appeared to loosen after lift-off due to blast. Release of the arm was timed.

APPENDIX B. (CONTINUED)

Item	Location	Type	Focal Length	Frame Rate	Focus	Exposure	Orientation	Field of View	Time Frame Reference	Coded Range Time
E-24	Launcher Position 5	16mm MILL	50mm	400	Good	Good	Good	Good	Usable	Usable

Required Orientation: Holddown arm I release jaw centered in left half of frame for study of holddown arm release action. Holddown arm I is located at 90° AZ. T.
Comments: Good coverage of the holddown arm and release mechanism. The holddown arm connect point on the vehicle moves inward prior to arm release. Release of the arm was obscured by frost and ice. The camera shifted downward after lift-off.

E-25	Launch Position 6	16mm MILL	50mm	400	Good	Good	Good	Good	Usable	Usable

Required Orientation: Holddown arm III-IV release jaw centered in right half of frame for study of holddown arm release action. Holddown arm III-IV is located at 225° AZ. T.
Comments: Considerable camera vibration was observed. Good coverage of holddown release. Static line released from vehicle was observed. Arm release was timed.

E-26	Launcher Position 7	16mm MILL	40mm	400	Good	Good	Good	Good	Usable	Usable

Required Orientation: Holddown arm IV release jaw centered in left half of frame for study of holddown arm release action. Holddown arm IV is located at 180° AZ. T.
Comments: Excellent coverage of release and retraction of the arm. Vehicle holddown leg at fin 4 moved laterally to the inside immediately prior to arm release. No malfunctions were observed. Release of the arm was timed.

APPENDIX B. (CONTINUED)

Item	Location	Type	Focal Length	Frame Rate	Focus	Exposure	Orientation	Field of View	Time Frame Reference	Coded Range Time
E-27	Launcher Position 10	16mm MILL	40mm	400	Good	Good	Good	Good	Usable	Usable

Required Orientation: Holddown arm II-III release jaw centered in right half of frame for study of holddown arm release action. Holddown arm II-III is located at 315° AZ. T.
Comments: Excellent coverage of release. No malfunctions were observed during release and lift-off. Flame and blast effects on short cable mast II were observed. Release of the arm was timed.

E-28	Launcher Position 11	16mm MILL	40mm	400	Good	Good	Good	Good	Usable	Usable

Required Orientation: Holddown arm III release jaw centered in left half of frame for study of holddown arm release action. Holddown arm III is located 260° AZ. T.
Comments: Excellent coverage of release and lift-off sequence. Flame and blast effects on short cable mast IV was observed during and after lift-off. Release of the arm was timed.

E-29	Launcher Position 3	16mm MILL	10mm	400	Good	Good	Good	Good	Usable	Usable

Required Orientation: Top of short cable mast II umbilicals centered in upper left quadrant of frame for study of umbilical release and mast retraction.
Comments: Frost and ice obscure the mast disconnect. Mast retraction was observed. Cover fails to close completely until hit by blast. Flame and blast impingement was observed on short cable mast II and LOX mast. Fin I-II vibration was observed during thrust build-up and after lift-off. Release time of the mast was not determined due to ice and/or frost.

APPENDIX B. (CONTINUED)

Item	Location	Type	Focal Length	Frame Rate	Focus	Exposure	Orientation	Field of View	Time Frame Reference	Coded Range Time
E-30	Launcher Position 8	16mm MILL	10mm	400	Good	Good	Good	Good	Usable	Usable

Required Orientation: Top of short cable mast IV umbilicals centered in upper left quadrant of frame for study of umbilical release and mast retraction.

Comments: Considerable movement of fin III-IV was observed during the thrust build-up and lift-off. Mast disconnect time was not determined due to frost and ice in field of view. Mast retraction rate was determined. Mast cover did not close immediately. Camera box loosened after lift-off. Flame and blast impingement on short cable mast IV and on launch table top was observed.

E-36	Launcher Position 9	16mm MILL	10mm	400	Good	Good	Good	Good	Usable	Unusable

Required Orientation: Center top of LOX fill line of mast III in upper right quadrant of frame to show line release and mast retraction.

Comments: Frost and ice obscures the mast disconnect. Coverage is good; however, camera orientation should be slightly higher. Mast retraction rate was not determined due to no timing.

E-37	Umb. Twr. 48' Lvl S. Plat.	16mm MILL	15mm	400	Good	Good	Good	Good	Usable	Usable

Required Orientation: Center top of fuel line of mast I in upper half of frame to show line release and mast retraction.

Comments: Release of fuel mast and short cable mast was not determined due to frost and ice. Cover on the short cable mast does not fully close.

APPENDIX B. (CONTINUED)

Item	Location	Type	Focal Length	Frame Rate	Focus	Exposure	Orientation	Field of View	Time Frame Reference	Coded Range Time
E-38	37A Umb. Twr. 248' Lvl.	35mm MIT	50mm	96	Good	Good	Good	Good	Usable	Usable

Required Orientation: Center vehicle and launch pedestal in frame for overall structural surveillance of vehicle, and flame effect on launcher and umbilical tower.
Comments: Good coverage of lift-off sequence. Tower clearance was marked and timed.

E-39	Top of BH	35mm MIT	50mm	96	Good	Good	Good	Good	Usable	Usable

Required Orientation: Center vehicle and launch pedestal in frame for overall structural surveillance of vehicle, and flame effect on launcher and umbilical tower.
Comments: Excellent coverage of ignition and lift-off through tower clearance. No malfunctions were observed. Water quench operation was observed.

E-40	Umb. Twr. 88' Lvl. S. Plat.	16mm MILL	50mm	400	Good	Good	Good	Good	Usable	Usable

Required Orientation: Center umbilical connectors of swing arm #1 in frame for detailed study of umbilical disconnect.
Comments: Some camera movement was observed during ignition. Swing arm access door closes then re-opens. Trailing wire was observed in field of view after lift-off. Release of the arm was timed.

APPENDIX B. (CONTINUED)

Item	Location	Type	Focal Length	Frame Rate	Focus	Exposure	Orientation	Field of View	Time Frame Reference	Coded Range Time
E-41	Umb. Twr. 178' Lvl. S. Plat.	16mm MILL	50mm	400	Good	Good	Good	Good	Usable	Usable

Required Orientation: Center umbilical connectors of swing arm #2 in frame for detailed study of umbilical disconnect.
Comments: Trailing wire was observed falling through field of view. Swing arm door #1 was observed still open. Release of arm was timed.

E-42	Umb. Twr. 178' Lvl. S. Plat.	16mm MILL	25mm	400	Good	Good	Good	Good	Usable	Usable

Required Orientation: Center umbilical connectors of swing arm #3 in frame for detailed study of umbilical disconnect.
Comments: Trailing wire was observed. Tank cover panel strikes face plate on arm contact mechanism. Release of arm was timed.

E-43	Umb. Twr. 218' Lvl. S. Plat.	16mm MILL	50mm	400	Good	Good	Good	Good	Usable	Usable

Required Orientation: Center umbilical connectors of LEM swing arm in frame for detailed study of umbilical disconnect.
Comments: Coverage of the release was excellent. Venting was observed from small hose on arm and from corresponding connect point on the vehicle. No malfunctions were observed.

APPENDIX B. (CONTINUED)

Item	Location	Type	Focal Length	Frame Rate	Focus	Exposure	Orientation	Field of View	Time Frame Reference	Coded Range Time
E-44	330° 350' 50' Twr.	16mm MILL	20 in	400	Good	Good	Good	Good	Usable	Usable

Required Orientation: Center umbilical connectors of swing arm #1 in frame for detailed study of umbilical disconnect.

Comments: Some heat shimmer was observed at ignition. Swing arm release was timed. Trailing wire was observed passing through field of view.

E-45	75° 375' 50' Twr.	16mm MILL	10 in	400	Good	Good	Good	Good	Usable	Usable

Required Orientation: Center umbilical connectors of swing arm #2 in frame for detailed study of umbilical disconnect.

Comments: S-IB swing arm access door remained open. Trailing wire was observed attached to S-IB stage. Arm release was timed.

E-46	75° 375' 50' Twr.	16mm MILL	20 in	400	Poor	Good	Good	Poor	Unusable	Usable

Required Orientation: Center umbilical connectors of swing arm #3 in frame for detailed study of umbilical disconnect.

Comments: Field of view was too low. Swing arm #1 access door remained open. Release time of swing arm #3 was obtained.

APPENDIX B. (CONTINUED)

Item	Location	Type	Focal Length	Frame Rate	Focus	Exposure	Orientation	Field of View	Time Frame Reference	Coded Range Time
E-47	75° 375' 50' Twr.	16mm MILL	20 in	400	Poor	Good	Good	Good	Usable	Usable

Required Orientation: Center umbilical connectors of LEM swing arm in frame for detailed study of umbilical disconnect.
Comments: Data lost due to poor focus.

E-48	Umb. Twr. 68' Lvl. S. Plat.	16mm MILL	10mm	400	Good	Good	Good	Good	Usable	Usable

Required Orientation: Center umbilical connectors of swing arm #1 in bottom edge of frame to show swing arm motion and vehicle clearance.
Comments: Good coverage of swing arm #1. Retraction rate was not determined due to frost and ice.

E-49	Umb. Twr. 88' Lvl. W. Plat.	16mm MILL	10mm	400	Good	Good	Good	Good	Usable	Usable

Required Orientation: Center umbilical connectors of swing arm #2 in bottom edge of frame to show swing arm motion and vehicle clearance.
Comments: Trailing wire was observed connected to tower and vehicle. Excellent coverage of swing arm release and retraction. Timing becomes erratic after 9 seconds; however, the release of the arm was timed.

APPENDIX B. (CONTINUED)

Item	Location	Type	Focal Length	Frame Rate	Focus	Exposure	Orientation	Field of View	Time Frame Reference	Coded Range Time
E-50	Umb. Twr. 158' Lvl. W. Plat.	16mm MILL	10mm	400	Good	Good	Good	Good	Usable	Usable

Required Orientation: Locate umbilical connectors of swing arm #3 in extreme right edge of frame to show swing arm action and vehicle clearance.
Comments: Retraction rate of swing arm #3 was obtained.

E-51	Umb. Twr. 238' Lvl. W. Plat.	16mm MILL	10mm	400	Good	Good	Good	Good	Usable	Usable

Required Orientation: Center umbilical connectors of LEM swing arm in upper right quadrant of frame to show swing arm motion and vehicle clearance.
Comments: Excellent coverage of swing arm 2, 3, and 4 release and retraction. Camera operates through start of water quench on GSE. Retraction rates of the arms were determined.

E-52	75° 375' 50' Twr.	16mm MILL	75mm	400	Good	Good	Good	Good	Usable	Usable

Required Orientation: Center umbilical swing arm #1 in bottom of frame to show swing arm motion and vehicle clearance.
Comments: Cable on mast disconnect and/or umbilical carrier appears to have broken and dropped. Good coverage of arm swing and vehicle clearance was obtained.

APPENDIX B. (CONTINUED)

Item	Location	Type	Focal Length	Frame Rate	Focus	Exposure	Orientation	Field of View	Time Frame Reference	Coded Range Time
E-53	330° 350' 50' Twr.	16mm MILL	75mm	400	Good	Good	Good	Good	Usable	Usable

Required Orientation: Center umbilical swing arm #2 in bottom of frame to show swing arm motion and vehicle clearance.
Comments: Vehicle clearance of swing arm #2 was observed and no anomalies were noted.

E-54	330° 350' 50' Twr.	16mm MILL	75mm	400	Good	Good	Good	Good	Usable	Usable

Required Orientation: Center umbilical swing arm #3 in bottom of frame to show swing arm motion and vehicle clearance.
Comments: Vehicle clearance of swing arm was observed with no anomalies noted.

E-55	330° 350' 50' Twr.	16mm MILL	75mm	400	Good	Good	Good	Good	Usable	Usable

Required Orientation: Center LEM umbilical swing arm in bottom of frame to show swing arm motion and vehicle clearance.
Comments: Camera operated as programmed; no malfunctions were observed.

APPENDIX B. (CONTINUED)

Item	Location	Type	Focal Length	Frame Rate	Focus	Exposure	Orientation	Field of View	Time Frame Reference	Coded Range Time
E-56	Umb. Twr. 88' Lvl. S. Plat.	16mm	10mm MILL	200	Good	Good	Good	Good	Usable	Usable

Required Orientation: Center top of launch table in frame to show flame and blast effects on launch table after vehicle lift-off.
Comments: Excellent coverage of flame impingement on GSE. Timing comes on late, the first 8 ft of film has no timing, then is good. No data loss since this is malfunction camera and no malfunction was observed during this time period.

E-61	37-1 50' Twr.	16mm	63mm MILL	500	Poor	Good	Good	Good	Usable	Usable

Required Orientation: Center the S-IVB stage in bottom of frame for structural surveillance of the S-IVB during booster ignition and lift-off.
Comments: Film unusable due to poor focus.

E-62	37-2 50' Twr	16mm	63mm MILL	500	Good	Good	Good	Good	Usable	Usable

Required Orientation: Center the S-IVB stage in bottom of frame for structural surveillance of the S-IVB during booster ignition and lift-off.
Comments: Retraction of swing arms 2, 3, and 4 was observed. Trailing wire was observed falling from the vehicle. No malfunctions were observed. No timeable events were recorded.

APPENDIX B. (CONTINUED)

Item	Location	Type	Focal Length	Frame Rate	Focus	Expo-sure	Orien-tation	Field of View	Time Frame Reference	Coded Range Time
E-63	37-3 50' Twr.	16mm MILL	63mm	500	Good	Good	Good	Good	Usable	Usable

Required Orientation: Center the S-IVB stage in bottom of frame for structural surveillance of the S-IVB stage during booster ignition and lift-off.

Comments: Good coverage of the stage. No malfunctions were observed. No timeable events were recorded.

E-67	Umb. Twr. 118' Lvl. Inside	35mm MIT	35mm	96	Good	Good	Fair	Good	Usable	Usable

Required Orientation: Center the S-IVB four vertical motion targets with the umbilical tower target in the upper left corner of frame to record vehicle vertical motion for the first 3 to 5 meters of flight.

Comments: Camera was oriented too high. Only the top two targets were in the field of view. Vehicle vertical motion was obtained. Film run was short but the required data was obtained.

E-68	37B-B	16mm MIT	15 in	12	Poor	Good	Good	Good	Usable	Usable

Required Orientation: Center the S-IVB LOX vent valve in frame for surveillance of LOX vent action.

Comments: Film load was exhausted approximately four hours prior to launch because cameras ran during the holds in the countdown.

APPENDIX B. (CONTINUED)

Item	Location	Type	Focal Length	Frame Rate	Focus	Exposure	Orientation	Field of View	Time Frame Reference	Coded Range Time
E-69	37-3	35mm MIT	20 in	2	Good	Good	Good	Good	Usable	Usable

Required Orientation: Center the S-IB LOX tank L-1 vent and LOX tank L-4 relief valve in frame for surveillance of LOX vent action.
Comments: Excellent coverage of venting action of the valves. No malfunctions were observed.

E-70	37A Umb. Twr. 128' Lvl.	35mm MIT	40 in	2	Good	Good	Good	Good	Unusable	Usable

Required Orientation: Center the S-IB LOX tank L-3 vent and relief valves in frame for surveillance of LOX vent action.
Comments: Malfunction surveillance camera. Vent stop time was noted. No malfunctions were observed. Camera operated through lift-off.

E-77	37-1 50' Twr.	16mm MILL	75mm	200	---	---	---	---	---	---

Required Orientation: Center the Apollo systems interface in bottom edge of frame for structural surveillance to the interface area during booster ignition and lift-off.
Comments: Camera did not operate.

APPENDIX B. (CONTINUED)

Item	Location	Type	Focal Length	Frame Rate	Focus	Exposure	Orientation	Field of View	Time Frame Reference	Coded Range Time
E-78	37-2 50' Twr	16mm MILL	75mm	200	Good	Good	Good	Good	Usable	Usable

Required Orientation: Center the Apollo systems interface in bottom edge of frame for structural surveillance of the interface area during booster ignition and lift-off.
Comments: Good coverage of the interface. Swing arms 3 and 4 and disconnects were observed. No malfunctions were observed. A wire was observed trailing from the vehicle.

E-79	37-3 50' Twr.	16mm MILL	75mm	200	Good	See Note	Good	Good	Usable	Usable

Required Orientation: Center the Apollo systems interface in bottom edge of frame for structural surveillance of the interface area during booster ignition and lift-off.
Comments: Camera exposure was under due to launch time. No malfunctions were observed.

E-80	37-4 30' Twr.	16mm MILL	4 in	200	Good	Good	Good	Good	Usable	Usable

Required Orientation: Center the Apollo systems interface in bottom edge of frame for structural surveillance of the interface area during booster ignition and lift-off.
Comments: Camera acquires vehicle after ignition and covers through loss of view. No malfunctions were observed as the vehicle passed through the field of view.

APPENDIX B. (CONTINUED)

Item	Location	Type	Focal Length	Frame Rate	Focus	Exposure	Orientation	Field of View	Time Frame Reference	Coded Range Time
E-85	Launcher Position 3A	16mm	10mm	400	Good	Good	Good	Good	Usable	Usable

Required Orientation: Center the three vehicle first motion targets with holddown arm target inside of frame for detailed study of first motion sequence.
Comments: Excellent coverage of the fixed and vehicle first motion targets. Ice and frost partially obscures the targets at first motion. No malfunctions were observed. First motion was timed.

E-86	Launcher Position 8A	16mm	10mm	400	Good	Good	Good	Good	Usable	Usable

Required Orientation: Center the vehicle first motion targets with holddown arm target inside of frame for detailed study of first motion sequence.
Comments: Frost and ice obscures the targets but coverage was excellent. No malfunctions were observed. Vehicle first motion was timed.

E-87	Under Window SV-M2 Theod.	35mm GIA	25mm	1	Good	Good	Good	Good	Usable	Usable

Required Orientation: Center bottom of launch pedestal in bottom edge of frame for observation of vapors during LOX venting of launch vehicle.
Comments: Venting was observed. No vapors obscure the IU window.

APPENDIX B. (CONTINUED)

Item	Location	Type	Focal Length	Frame Rate	Focus	Exposure	Orientation	Field of View	Time Frame Reference	Coded Range Time
E-88	Under Window SV-M2 Theod.	35mm GIA	9 in	1	Good	Good	Good	Good	Usable	Usable

Required Orientation: Center the IU window in frame for observation of vapors during LOX venting of launch vehicle.
Comments: No LOX vapors observed obscuring IU window.

E-89	37-4 30' Twr.	35mm MIT	4 in	1	Good	Good	See Note	Good	Usable	Usable

Required Orientation: Locate launch vehicle in left edge of frame and elevate camera to center IU in the vertical for observation of vapors during LOX venting of launch vehicle.
Comments: Camera orientation was high, IU should be centered in the vertical. No data loss since no vapors were observed obscuring the IU window.

E-103	37-1	35mm MIT	40 in	2	Good	Good	Good	Good	Usable	Usable

Required Orientation: Center the S-IB LOX tank L-2 vent in frame for surveillance of LOX vent action.
Comments: No malfunctions were observed. Vent start was timed.

APPENDIX B. (CONTINUED)

Item	Location	Type	Focal Length	Frame Rate	Focus	Expo-sure	Orien-tation	Field of View	Time Frame Reference	Coded Range Time
1.2-1 RH	U306L213	35mm	40 in	96	Good	Good	Good	See Note	Usable	Usable

Required Orientation: Tracking: Entire vehicle centered for surveillance before lift-off and during early flight. Film run T-10 seconds to T+75 seconds.
Comments: Field of view too small. Field of view includes upper half of S-IB stage, S-IB/S-IVB inner stage and lower half of S-IVB stage. Coverage extends through staging but the staging events were not timed due to lens size.

1.2-2 RH	U286L72	35mm	20 in	96	Good	Good	Fair	Good	Unusable	Usable

Required Orientation: Tracking: Entire vehicle centered for surveillance before lift-off and during early flight. Film run T-10 seconds to T+75 seconds.
Comments: Camera was oriented too low. Nose cone was not in view at lift-off or during early flight. Smoke partially obscures field of view during lift-off. First particle was observed. Film run was through staging. Staging events were timed.

1.2-3 RH	U122L29	35mm	40 in	96	Good	Good	Good	Good	Usable	Usable

Required Orientation: Tracking: Entire vehicle centered for surveillance before lift-off and during early flight. Film run T-10 seconds to T+75 seconds.
Comments: Vehicle acquired on pad. Tower clearance was timed. Tracking coverage was good. Three falling particles were observed. Coverage did not extend through staging.

APPENDIX B. (CONTINUED)

Item	Location	Type	Focal Length	Frame Rate	Focus	Expo-sure	Orien-tation	Field of View	Time Frame Reference	Coded Range Time
1.2-4 RH	U306L213	35mm	80 in	96	Good	Good	Good	Good	Usable	Usable

Required Orientation: Tracking: First stage centered until entire vehicle is in frame for flight and structural surveillance. Film run T-10 seconds to LOV.
Comments: Camera acquires vehicle on the pad. Stage was not visible due to late evening launch. No malfunctions were observed. Camera did not track vehicle to separation.

1.2-5 RH	U286L72	35mm	80 in	96	Good	Good	Good	Good	Usable	Usable

Required Orientation: Tracking: First stage centered until entire vehicle is in frame for flight and structural surveillance. Film run T-10 seconds to LOV.
Comments: Vehicle acquired on pad. Smoke obscures early flight. Tracking coverage was good to LOV.

1.2-6 RH	U102R6	35mm	120 in	96	Good	Good	Good	Good	Usable	Usable

Required Orientation: Tracking: First stage centered until entire vehicle is in frame for flight and structural surveillance. Film run T-10 seconds to LOV.
Comments: Good tracking coverage from lift-off through staging. Retro and ullage sequence was timed.

APPENDIX B. (CONTINUED)

Item	Location	Type	Focal Length	Frame Rate	Focus	Exposure	Orientation	Field of View	Time Frame Reference	Coded Range Time
1.2-7 RH	U306L213	35mm	120' *	96	Good	Good	Good	Good	Usable	Usable

Required Orientation: Tracking: Nosecap and LM adapter centered in frame for structural surveillance. Film run T-5 seconds to T+60 seconds. *Focus at 15,000 ft.
Comments: Good coverage of the nosecap and upper portion of the S-IVB stage from S-IB ignition to approximately 70 seconds of flight. No malfunctions were observed.

1.2-8 RH	U140L62	35mm	120' *	96	Good	Good	Good	Good	Usable	Usable

Required Orientation: Tracking: Nosecap and LM adapter centered in frame for structural surveillance. Film run T-5 seconds to T+60 seconds. *Focus at 15,000 ft.
Comments: Good coverage of the nosecap and part of the S-IVB during ignition and lift-off through approximately 70 seconds of flight. No malfunctions were observed.

1.2-9	U699L366 (UC 9)	70mm	500 in	30	Good	Good	Good	Good	Usable	Usable

Required Orientation: Tracking: From first acquisition to LOV. First stage centered until entire vehicle is in frame for flight and structural surveillance.
Comments: Tracking coverage was as programmed. All separation events were timed except ullage engine start. Plume study was unobtainable due to lack of vehicle definition caused by the sun angle. No malfunctions were observed.

APPENDIX B. (CONTINUED)

Item	Location	Type	Focal Length	Frame Rate	Focus	Exposure	Orientation	Field of View	Time Frame Reference	Coded Range Time
1.2-10 RH	RTCB	70mm	400 in	30	Good	Good	Good	Good	Usable	Usable

Required Orientation: Tracking: From first acquisition to LOV entire vehicle centered in frame for flight and structural surveillance.

Comments: Good coverage of vehicle during S-IB stage powered flight through S-IB/S-IVB separation. All events were recorded through separation except J-2 engine ignition.

Item	Location	Type	Focal Length	Frame Rate	Focus	Exposure	Orientation	Field of View	Time Frame Reference	Coded Range Time
1.2-11 RH	PAFB (MITTS)	35mm 160R	360'	32	Good	Good	Good	Good	Usable	Usable

Required Orientation: Tracking: First acquisition to LOV for flight and structural surveillance, first stage centered until entire vehicle is in frame.

Comments: Tracking was somewhat erratic. Staging events were timed. No malfunctions were observed.

Item	Location	Type	Focal Length	Frame Rate	Focus	Exposure	Orientation	Field of View	Time Frame Reference	Coded Range Time
1.2-12 RH	RTMB	70mm	500 in	30	Good	Under	Good	Good	Usable	Usable

Required Orientation: Tracking: From first acquisition (but not before T+25 seconds) to LOV for flight and structural surveillance and S-IB/S-IVB separation.

Comments: Good coverage of the entire vehicle from approximately T+25 seconds through S-IB/S-IVB separation and continues to track the S-IVB through approximately T+170 seconds. All staging events were timed. No malfunctions were observed.

APPENDIX B. (CONCLUDED)

Item	Location	Type	Focal Length	Frame Rate	Focus	Exposure	Orientation	Field of View	Time Frame Reference	Coded Range Time
1.2-1	ALOTS	70mm	200	30	Good	Good	Good	Good	Usable	Usable

Required Orientation: Airborne Tracking: T+40 seconds through staging.
Comments: Good coverage of the entire vehicle from first acquisition (T+40 seconds) through approximately T+191 seconds. The camera tracks the S-IB and S-IVB after separation until the S-IB was out of the field of view at T+174 seconds. All separation events were timed and no malfunctions were observed.

The following items are surveillance and/or emergency cameras and the film was not processed: E-64, E-65, E-66, E-73, E-74, E-75, E-76, E-81, E-82, E-83, E-84, E-90, E-91, E-92, E-93, E-94, E-95, E-96, E-97, E-98, E-99, and E-100.

The following items were deleted for the SA-204/LM-1 launch: E-2, E-3, E-4, E-9, E-11, E-14, E-16, E-17, E-18, E-19, E-20, E-35, E-57, E-58, E-59, E-60, E-71, E-72, E-101, E-102, E-104, E-105, E-106, and E-107.

The following items were special test items: E-31, E-32, E-33, and E-34.

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OPTICAL INSTRUMENTATION DATA EVALUATION OF THE SA-204/LM-1 SATURN IB LAUNCH VEHICLE

Approved: Norman G. McDonald
N. G. McDonald, Supervisor
Propulsion Systems Performance Evaluation Group

Approved: J. E. Diehl
J. E. Diehl, Managing Engineer
Systems Simulation and Evaluation Section

Approved: W. M. Cannizzo
W. M. Cannizzo, Manager
Systems Simulations and Integration Branch

Approved: H. Bader, Jr.
H. Bader, Jr., Chief Engineer
Structures and Mechanics Engineering Department

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